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NAVAL DEPARTMENT ORGANIZATION.

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For nearly a century and a quarter we have had a Navy, and one whose deeds and conduct throughout its history have honored both itself and the country. But while its record has been so honorable in respect to action, it has made a signal failure in the development of any administrative system which has not been more or less a makeshift until, under the law of 1862, we reached and have remained in a sort of *impasse*. We were only saved from the worse effects of this during the civil war by a most efficient Chief of Staff in the person of Assistant Secretary Fox, in earlier life a naval officer.

I enter on a discussion of the subject with a full recognition of its very great difficulty; a difficulty far more serious than any one can suppose who has not attempted a study of it. The earnest thought of many able minds in many countries has been given to it, particularly in England where Parliamentary Commission has

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succeeded Parliamentary Commission in study of the questions involved; and though entire satisfaction has nowhere been arrived at, and probably never will be, certain principles may be taken as established, and have been accepted in the greater naval administration.

Feeling strongly these difficulties and the magnitude of the question, what I shall say will, I hope, not be taken as said in anywise dogmatically, but only as with an earnest endeavor to suggest a system more in accord with what has been found necessary by powers dealing with the subject on a much larger scale and under the much greater pressure of an ever present prospect of war. Given like results to be attained, men whatever their nationality, will generally work on the same lines, differing only in the slighter means due to the genius of their race. Thus whatever is found established elsewhere is of great value as a study when a like business is to be newly organized. This is a principle seemingly largely ignored in all the various endeavors to formulate a departmental system for the Department of the Navy. A *résumé* of these various endeavors is worth giving as a preliminary to our subject.

The first effort dates the 11th of December, 1775, when it was "*Resolved* that a committee be appointed to devise ways and means for furnishing these Colonies with a naval armament and report with all convenient speed."

This committee reported the 13th of December of the same year, the report being agreed to, that there should be built five ships of 32 guns, five of 28, and three of 24 guns, at a cost of $866,666\frac{2}{3}$, and it was "*Resolved* that a committee be appointed with full powers to carry the said report into execution . . ."

This was the beginning of our naval legislation, and the future proceedings of Congress are interspersed with short resolutions of like tenor, as "that the direction of the fleet fitted out by order of Congress be left to the Naval Committee." "That the committee be empowered to affix the names to each particular ship and determine the vessel which each captain is to take command of;" "to order the ships and armed vessels belonging to the Continent out on such cruises as they shall think proper," until 28th of October, 1779, it was "*Resolved*, that a Board of Admiralty be estab-

lished to superintend the naval and marine affairs of these United States, to consist of three commissioners, not members of Congress, and two members of Congress, any three of whom to form a board for the despatch of business; to be subject in all cases to the control of Congress."

This board had full powers to form plans for increasing the naval force, control the movements of ships, direct such navy boards as were or should be established; and in general, to superintend and direct all the branches of the marine department.

The 7th of February, 1781, it was "*Resolved*, that there be a Superintendent of Finance, a Secretary of War and a Secretary of Marine," which last named was, "in general, to execute all the duties and powers specified in the Act of Congress constituting the Board of Admiralty."

They did not, however, seem to get so far as to appoint such Secretary, as on report of a committee it was *Resolved*, that an agent of the marine be appointed "with authority to direct, fit out, equip and employ the ships . . according to such instructions as he shall from time to time receive from Congress."

Such agent after a considerable interval was appointed, his "duties, powers and authority in this interval devolving upon the Superintendent of Finance."

The 7th of August, 1789, the United States Government now being organized on a permanent basis, the "Department of War" was created, the Secretary for the Department acting for both the land and naval forces, until the 30th of April, 1798, when was created the "Department of the Navy," the "chief officer of which shall be called the Secretary of the Navy."

Section 2 of this Act provided that a principal clerk and such other clerks as he shall think necessary shall be appointed by the Secretary of the Navy, who shall be employed in such manner as he shall deem most expedient.

Under this organization the Navy led a hand to mouth existence, at times well nigh moribund, but all the same growing immortal laurels on the Barbary coasts and fitting itself for the brilliant deeds of the second British war, when, the 7th of February, 1815, the President was authorized to appoint three officers of the Navy not below the rank of a post captain, "who shall constitute a board of commissioners for the Navy of the United States . . .

and the board so constituted shall be attached to the office of the Secretary of the Navy, and, under his superintendence, shall discharge all the ministerial duties of said office, relative to the procurement of naval stores and material, and the construction, armament, equipment and employment of vessels of war, as well as all other matters connected with the naval establishment of the United States."

This organization was, on a very limited scale, similar to that of the English. It had the defect, however, of ordering that the senior officer should preside, thus causing the board as a whole to report its proceedings to the Secretary, and differentiating it entirely too much from the Secretary's office. Had the Secretary presided at board meetings, and the duties of superintendence been divided amongst the several members of the board, and the more important questions discussed in the full board, this organization, beyond little doubt, would have lived and grown in favor. The enactment regarding the presidency in board meetings was a fatal flaw, sure finally to cause dissatisfaction and strained relations between the board and the Secretary. The consequence was that the 31st of August, 1842, this organization was displaced by the law ordering "that there shall be attached to the Navy Department the following bureaus, to wit:

"1. A Bureau of Navy Yards and Docks.

"2. A Bureau of Construction, Equipment and Repair.

"3. A Bureau of Provisions and Clothing.

"4. A Bureau ot Ordnance and Hydrography.

"5. A Bureau of Medicine and Surgery."

The Chiefs of the bureaus of "Navy Yards and Docks" and of "Ordnance and Hydrography" were to be appointed from the captains in the Navy, the Chief of "Construction, Equipment and Repairs" was to be "a skilfull naval constructor" who thus could be appointed from persons outside the service, as could also be the Chief of "Provisions and Clothing." Whether there was unusual talent among the captains, or whether there was some other reason governing, the Chiefs of the Bureau of Construction, Equipment and Repair were taken for ten years from amongst the captains in the face of a mandatory law, and it was not until November, 1853, that John Lenthall was appointed Chief of this bureau from civil life, though there were seven naval constructors

in the service. Attached to this bureau and part of it were Daniel B. Martin as Engineer-in-Chief and three Assistant Engineers.

Charles W. Goldsborough, also from civil life, was Chief of the Bureau of Provisions and Clothing.

It may not be uninteresting to state some details regarding the personnel of the administration during these years.

In 1842, the Office of the Secretary consisted of Secretary Upshur and eight clerks.

The Office of the Navy Commissioners, of Captains Warrington, Crane and Conner, six clerks and one draughtsman.

This constituted the entire personnel of the Department.

Next year, under the new organization, there were the Secretary's Office: Secretary David Henshaw, and ten clerks.

The Bureau of Navy Yards and Docks: Captain Warrington, three clerks, a civil engineer and a draughtsman.

The Bureau of Ordnance and Hydrography: Captain Crane, three clerks and a draughtsman.

The Bureau of Construction, Equipment and Repairs: Captain Kennon, four clerks and a draughtsman.

The Bureau of Provisions and Clothing: Charles W. Goldsborough and three clerks.

The Bureau of Medicine and Surgery: Surgeon Barton and two clerks.

It was not until 1846, that a Chief Constructor, Humphreys, and an Engineer, Charles Haswell, were attached to the Bureau of Construction, both from civil life, in which year Captain Charles Morris was Chief of this Bureau, and Captain Shubrick Chief of the Bureau of Provisions and Clothing; the latter occupied this post during the years 1845–46 and 47, in which last year he was succeeded by Gideon Welles, from civil life, a name destined to occupy a very prominent place fourteen years later. Mr. Welles was succeeded in 1850 by William Sinclair. Captain Shubrick was the last captain to occupy the post of Chief of the Bureau of Construction, Equipment and Repairs: a law was passed in 1853 that a constructor should be appointed to the place, as was the evident intent of the law of 1842, and John Lenthall, who had been Chief Constructor "attached to the Bureau" since 1850, was made Chief of Bureau. In 1855, Purser Horatio Bridge was made Chief of the Bureau of Provisions and Clothing, the first officer of the Pay Corps to occupy this position.

The law of 1842 just failed of the establishment of an effective system. Had the Board of Navy Commissioners been retained, and had it been attached to the Secretary's Office instead of being so largely independent of it as it was by law, the result would have undoubtedly been the working out of excellent organization, which would have been almost that of England. The new law was a distinct advance upon its predecessor, but the entire abrogation of the Navy Commissioners was as distinct a mistake.

Things remained thus until in 1862, when during the stress of war time, Equipment and Steam Engineering were separated from Construction and made into bureaus, and the final blow was thus given to an already inadequate system.

In March, 1891, the office of Assistant Secretary of the Navy was established.

The organization of 1862 stands to-day, and we have the administration divided among eight bureaus, each charged with such duties as may be assigned it by the Secretary of the Navy.

They all stand on the same footing, and under the law orders issued by a bureau shall be regarded as having the force of an order by the Secretary. As arranged we have:

The Bureau of Navigation, charged in general terms with the personnel, both officers and men; their detail to duty; discipline; uniform; the Naval Academy; training establishments; the Hydrographic Office and movements of the fleet.

The Bureau of Ordnance: Ordnance, ordnance material and torpedoes.

The Bureau of Construction and Repair: Design, construction and repair of ships.

The Bureau of Steam Engineering: Design, construction and repair of steam propelling machinery.

The Bureau of Equipment: Electrical works; rigging, sails, cordage, anchors, chains; supply of coal to the fleet; navigational and signal supplies; libraries; the Naval Observatory and Nautical Almanac.

The Bureau of Supplies and Accounts: Provisions, clothing and small stores; the custody, transfer and issue of all supplies and the records of all property and plants (with some exceptions); accounts and pay of the navy.

The Bureau of Yards and Docks: Public works in navy yards and at naval stations.

The Bureau of Medicine and Surgery: whose name explains its work.

A Department of Law, at the head of which is the Judge-Advocate-General.

An Office of Naval Intelligence has been established; this, however, does not exist by mandate of law, but was formed as a necessity. Elsewhere it is regarded as an essential part of a general staff, and it would at once drop into its proper place in the event of a war, necessity bringing a result in our case which is arrived at elsewhere by the foresight bred of the imminency of war.

The author of the law, establishing the above organization of unsurpassed crudity and ease of device, was one who evidently had never thought it worth his while to give any thought to the study of such a thing as administrative systems. He thought it enough to tell A to do this, and B to do the other, and notwithstanding the rather self evident fact that the duties of A and B must touch at numberless points, and wherever touching there must be some means of adjusting the work of A to that of B, he left out entirely any machinery for such adjustment, leaving the whole to work out its own salvation, and throwing the heavy duty of reconcilement of divergent views, processes and ideas upon the Secretary of the Navy, who is thus called upon to decide differences of most technical character, and much of whose time is taken up with questions which under any proper system need never come before him.

Though so defective in one of the basic elements of good administration the bureau system has done some things well. The specific work of each bureau has been well looked after, work promptly accomplished, and supply well kept up. The other defects besides want of correlation have not been inherent in the system itself. The difficulties were largely the outcome of want of system in yard administration and of loose systems of accounts which in some respects, until after the civil war, were hardly existent; in the effects of the war itself, which necessarily filled the yards with material, much of which shortly became obsolete; and in the general decay, to 1882, of the whole naval establishment.

If we analyze naval administration it will be seen that there are four, and that there can only be four natural divisions, viz.:

1. The supplying the ship, armed, equipped and provisioned.
2. The supplying the officers and men.
3. Directing her movements after 1 and 2 are complete.
4. Keeping the accounts of the whole.

The first division stands to the Navy in the position of the ship-builder to the owner of the steamship line; the third represents the management; the second and fourth are the usual and necessary adjuncts of the office.

The first is thus the navy yard division, and should embrace everything connected with navy yard management. For this there should be one central superintendence, commandants of yards being the agents of this central authority. This central authority should be the correlator of all the many divisions of the Navy Department concerned with the yard work, whose only adjuster, as before said, when a difference of opinion arises, is now the Secretary of the Navy.

These differences are generally on technical details, which should be dealt with by a naval officer, or by one whose whole attention could be given to such and upon whom the adjustment of all routine details should fall. Matters relating to construction and design, of greater moment, should be referred to a Board on Construction, hereinafter to be mentioned, and whose decisions, except in cases of extraordinary questions, should relieve the Secretary of all responsibility for technical matters referred to it.

The Department would thus be arranged as exhibited in the accompanying tabulation which gives in a general manner the duties assigned each section.

As the ship with her armament is the beginning of the whole, the duties will be taken in the order of

Ordnance, Construction, Steam Engineering, Equipment, General Stores, Provisions and Clothing, Public Works.	Under the Superintendent of Material.
Personnel.	
The General Staff.	
Pay and Accounts.	

THE SUPERINTENDENT OF MATERIAL.

a. Ordnance Branch.—Design and manufacture of ships' armaments; armor; gunnery-fittings of ships; to fix details of magazines, shell-rooms and turrets; small-arms; ammunition; torpedoes.

b. Construction Branch.—Preparation of designs for ships; the building and launching of ships; the operation and care of dry docks; the care and preservation of ships out of commission; the superintendence of contract work of a constructive character.

c. Steam Engineering Branch.—Preparation of designs for propelling machinery; the building, repair and installation of all steam propelling machinery at navy yards; the superintendence of contract work of like character.

d. Equipment Branch.—Electrical work and supply; supply of coal to ships; rigging, cordage, anchors, chains, sails; navigational and other scientific instruments for use afloat; flags; signal apparatus and material; libraries; carpets, curtains and mess furniture for ships; galleys.

e. General Store Branch.—The supply of non-technical stores common to several branches.

f. Provisions and Clothing.—Provisions, clothing and small stores.

g. Public Works Branch.—Docks, wharves, navy yard buildings and yard works in general.

(All the foregoing branches to correspond directly with commandants of yards respecting routine work; all other letters to be signed by the Superintendent of Material. All letters from the commandants to be addressed to the Superintendent of Material, with the branch for which designed to be noted at head of letter.)

PERSONNEL.

The detail of officers and establishment of complements of ships: the enlistment of men; the Naval Academy; training establishments; receiving ships; discipline; uniform; the Naval Observatory; the Hydrographic Office.

THE GENERAL STAFF.

The movements of the fleet; inspection of ships; preparation of plans of campaign; the Intelligence Office; naval attachés; the receipt and sending out of all communications from and to ships

in commission; all orders to officers affecting ships in commission to pass through the General Staff; all correspondence from ships necessary to go to the Superintendent of Material to be forwarded by the General Staff.

PAY AND ACCOUNTS.

The pay and accounts of the Navy in general.

The accompanying table presents in detail the proposed arrangement.

It is thus proposed that each branch of material shall store and handle the material singular to it, but that all general material shall be supplied through the general stores, and when drawn thence taken up on the branch store account.

All experience has shown such branch stores (with the materials in which the head of department is the only head having special and expert knowledge) to be a necessity. I do not think there is any possible gainsaying this fact. The idea of one great store in which everything should be received and from which materials should be retailed as needed by the several departments is a tempting one, and one which I frankly admit having long held myself, but I came gradually to see the impossibility. Without the branch store there can be no proper responsibility for material drawn from general store for work, and if not established by order it is established by foremen on their own account. It is a case in which necessity is too strong to be overborne by regulation. This is clearly shown, not only in our own experience but in that of the English, as will be seen by the report of the committees on Dock Yard Administration and Expenditure (1887).

By our present arrangement a foreman brings a stub requisition to, say, the Constructor of the yard for his signature for, say, five pounds of copper nails; the foreman draws these for a specific work, and the question as to whether any unused portion shall be returned or not is entirely with himself; had he the branch store to which to turn them in he would, under the minuter surveillance of such a store, and with the greater ease of making such a return, almost certainly make it; as it stands, the chances of a return of things unused is small indeed; the accounting part in most cases is at an end.

The general store proposed would be drawn on by the several

THE SECRETARY.

THE JUDGE ADVOCATE GENERAL.

THE SECRETARIAT OF THE SECRETARY'S OFFICE.

THE GENERAL STAFF
(*Chief*, a Line Officer of Rank).

Movements of the Fleet.
Inspection of Ships in Commission.
The Office of Naval Intelligence.
(All correspondence to or from the fleet in commission to pass through the General Staff.)

THE BUREAU OF PERSONNEL
(*Chief*, a Line Officer of Rank).

Officers.
Men.
Discipline.
Uniform.
The Naval Academy.
Training Establishments.
The Naval Observatory; The Hydrographic Office.
The Nautical Almanac.

(The Colonel-Commandant of Marines)

Marines.

(The

Medic
Hosp

THE NAVAL COUNCIL.

The Chief of the General Staff, the Chief of Personnel, the Superintendent of Material, the Senior Admiral of the Navy not afloat, the head of Board and the head of the Board on Construction.

If matters not military be discussed, the officer in the Navy Department representing each corps affected by the discussion to be a temporary

PROPOSED DEPARTMEN

(The Surgeon-General)

Medicine and Surgery.
Hospitals.

ORDNANCE BRANCH

(*Chief*, a Line Officer).

Design and Construction of Ordnance and Gun Mountings.
Ordnance Supply.
Armor.
Torpedoes.
Specialized Material.
Accounts.

CONSTRUCTION BRANCH

(Chief Constructor).

Ship Design.
Navy Yard and Contract Work.
Specialized Material.
Accounts.

STEAM ENGINEE

(Engineer-i

Design of Steam Propelli
Navy Yard and Contract
Specialized Material.
Accounts.

THE BOARD ON CONSTRUCTION.

e head of the Inspection

mporary member.

A Flag Officer, a Captain, a Commander, a Lieutenant-Commander, a Naval Constructor, a Chief-Engineer; a Lieutenant or
as recorder.

NOTE.—An assistant to be established by la

NTAL ORGANIZATION.

THE ASSISTANT SECRETARY.

THE SUPERINTENDENT OF MATERIAL

(a Flag Officer of large Navy Yard Experience).

INEERING BRANCH

ineer-in-Chief).

opelling Machinery.
ntract Work.
l.

EQUIPMENT BRANCH

(*Chief*, a Line Officer).

Electrical Work.
Coal for Ships.
Rigging. Cordage. Sails. Anchors. Chains. Navigational and Scientific Instruments, for use afloat. Signal Materials. Libraries. Mess Furniture. Galleys.
Specialized Material.
Accounts.

GENERAL STORE BRANCH

(*Chief*, a Pay Officer).

Stores Common to several Branches.
Accounts.

PROVISIONS AND CLO

(*Chief*, a Pay O

Provisions, Clothing and Sm
Accounts.

THE BOARD OF INSPECTION AND SURVEY.

t or Assistant Naval Constructor

A Flag Officer, a Captain, a Commander, a Lieutenant-Commander, a Lieutenant (recorder), a Medical Officer, a Naval Constructor, a Marine Officer.

by law in each Bureau and Branch.

THE BUREAU OF PAY AND ACCOUNTS

(the Paymaster-General).

The Pay of the Navy. The Accounts of the Navy.

ND CLOTHING BRANCH

', a Pay Officer).

ng and Small Stores.

PUBLIC WORKS BRANCH

(*Chief*, a Line Officer).

Docks and Wharves.
Navy Yard Buildings.
Specialized Material.
Accounts.

al Officer, an Engineer Officer,

branches, as is now the Naval Supply Fund, the stores themselves being kept up by this fund, reimbursed from the appropriations against which the stores are drawn, and thus independent of yearly appropriations.

Though technically we now have one general store for all articles except for those termed "exempt" in equipment, it is far otherwise in practice, and must be so whatever the system. The vast variety of ordnance material has and must have a separate disposition, and must be looked after by special men; the same separate disposition and special care exist, as just stated, for electrical supply, sextants, chronometers, and all this *genus* in equipment; separate storage at points selected for convenience and economy in handling, must be arranged for great quantities of material in construction and steam engineering. It is unquestionably, as far as the work of a yard is concerned, far better that all such material should have its special responsible storekeeper, and be under the control and daily inspection of the head of department using it, than technically under the control of one officer who, in the nature of things, cannot give it personal attention, and who can have no special concern regarding it excepting that respecting accounts. While a strict system of accounts is a necessity of any proper system, we should not lose sight of the necessities of yard work.

There is no difficulty in keeping close and accurate accounts in such a system, with the branch storekeeper held to strict accountability. The accounts of all branches would be rendered to the Paymaster-General, and payments of purchases would be made by him on vouchers sent through the branch concerned, making practically no changes from the present system, except to shorten work and diminish the number of papers.

The Paymaster-General would be, as now, the accountant-general of the Navy, and the branches of material having the cognizance of the appropriations allotted to them, would always be in much closer touch with their financial status, and with their status as to stores on hand at any given time. Periodical stock-taking should be made a matter of strict regulation, and there should be frequent inspection of navy yard store accounts by an inspector of navy yard accounts, acting under the Paymaster-General.

When one considers the immensely difficult and technical field

of vast extent covered by the supply of material to the Navy, and the necessity of its being handled by experts in order to insure efficiency, it is clear that neither the Navy nor any other profession furnishes a man capable of dealing with it as a whole. I suppose it may be taken for granted that the line officer uses and is brought in actual contact with more of what belongs on board a ship than the officer of any other corps; the engineer officer occupies a large field of specialties; the constructor deals with many others. No one of the three is or can be conversant with all, and no one of any other corps in the duties of his profession is made cognizant with any. The care proper to special articles can only be given by those who understand and use them, and this care is best given by those who are responsible for their efficiency when worked into or placed aboard a ship.

I have omitted a special purchase department, as the arrangement proposed obviates the difficulties of which Mr. Whitney spoke in his Report of 1885. It may be taken as a principle, that there should be no indirection which may be avoided, so long as such avoidance is compatible with the interest of the Government. It is thus proposed that the order for purchase go direct from the branches of Material to the Purchasing Paymaster and that all correspondence relating to the subject be direct between the branch purchasing and the purchasing agent, all questions relating to purchases or contracts to be submitted to the Judge-Advocate-General's office.

Article 3718 of the Revised Statutes should be annulled and naval purchase put upon the same footing as purchases for the Army, which are governed by Article 3709. Time, money and quality would be saved to us if other laws and regulations relating to army purchases should be adopted, and I certainly can see no reason why they should not be.

There is in the English system a "Director of Contracts," a permanent civil official who makes the greater number of purchases required by the several departments of the Admiralty. There is a large class of exceptions, however, of special material which are bought by direct action of the controller (who corresponds to the proposed Superintendent of Material), and there is a strong feeling that the exceptions should be largely extended.

Two vitally necessary adjuncts to a good administrative system are the Naval Council and the Board on Construction, shown in the table. The Board of Inspection, also shown in the table, we already have. The Naval Council is the natural and necessary means for the discussion of the larger questions of naval policy, many of which are too technical to be dealt with by the Secretary alone, and are, whether technical or not, frequently impossible of decision without discussion. As it stands, there is no one to call upon except such person as the Secretary may regard as advisable to have as an adviser in any given matter. No responsibility can attach to such a one. If his advice is a mistake there is an end of it, except that there may be a want of confidence in the future. The wisest of men stated as a dictum that "in a multitude of counsellors there is safety," and all nations with important navies, excepting ourselves, have acted upon it. The head of the department loses no freedom of action, but he has the benefit of discussion of an intricate and difficult subject by selected men and from the standpoint of several independent minds acting under a recognition of the fact of a fixed and direct responsibility. England possesses such a Council in the Board of Admiralty which also serves as the Board on Construction. France has her "Superior Naval Council" and a separate "Board of Works." Italy combines the two, in her "Superior Council of the Navy."

All large questions of construction, armament, etc., should come before the Board on Construction. Preliminary plans of ships should be laid before it for criticism and suggestion. We have attempted to establish a board somewhat of this character, but the mistake was made of forming it of the men charged with the initial preparation of all work. The disadvantages and defects of a board so constituted are obvious. It is composed, too, of officers whose time is so fully occupied that it is impossible that they should be able to give proper attention to the many intricate questions they are called upon to consider.

It is believed that the foregoing outlines a sound system of naval administration. It makes a logical division of duties, fixes responsibility for the material, personnel and handling of the fleet; places specialized material under the specialists whose duty it is to handle it, makes a general store of general articles, independent

of specific yearly appropriations for such stores, and makes an accountant department covering the accounts of the whole as fully as now. I believe it to be thoroughly workable.

Appended, for the sake of comparison, are the Naval Departmental Organizations of England and France, which, as connected with the oldest and largest naval services, may be taken as best worth our study.

DISCUSSION.

Captain H. C. TAYLOR, U. S. N.:—I shall have only a few words to say concerning Commander Chadwick's excellent paper. Although our studies of naval warfare at the War College bring us occasionally face to face with questions of naval organization and naval policy, yet with the Naval *Department* Organization our studies seldom have much to do. It does not, however, need an expert to perceive that Commander Chadwick's proposed plan is methodized and systematic. I think we all recognize a great loss of effective power in a departmental system which, while dividing the work among various sub-departments, called bureaus, does not provide for their conjoint united effectiveness. Such a defect results usually in failure to properly assign responsibility; while at other more busy or critical periods this wandering and unattached responsibility fastens itself inevitably upon some one man whose tastes or temperament fit him, more or less, to assume so large a task.

When emergencies find such a character as Mr. Fox in 1861, ready to bear the burden, defects of the system are hidden and overlaid by ability and strength of will in the central figure. When, however, wars or rumors of wars discover no such individual on the stage of public events, confusion ensues, followed possibly by national mortification.

Among the details of the General Staff, it might be well to insert the Naval War College which, in conjunction with the Office of Naval Intelligence, will, it is hoped, in the future do much toward the efficiency of the General Staff.

Commander EDWIN WHITE, U. S. Navy:—I have read the paper of Commander Chadwick and have carefully considered the measures he has proposed for the carrying on of administrative work allotted to the Navy Department. I believe he is correct in what he says in one of the closing sentences of his paper, to wit:

"It makes a logical division of duties, fixes responsibility for the material, personnel and handling of the fleet, places specialized material under

THE FIRST LORD.

General Direction.
Political Questions.
Board Questions.

Note.—While all the members of the Commission for executing the office of Lord High Admiral are technically on the same footing, it is not so in fact: the First Lord has supreme control, and the First Sea Lord is in practice Chief of Staff, and exercises a general control over his associates (other than First Lord). None of the other Sea Lords could remain on the Board if there were a marked divergence of views from those of the First Sea Lord.

Note.—The procedure with reference to design is as follows: the Controller, after obtaining the written approval of the First Sea Lord with reference to speed, armament and complement, instructs the Director of Construction to prepare a sketch design.

The Director of Construction obtains the opinion in writing of the Director of Ordnance and Engineer-in-Chief as to their respective branches and submits a sketch to the Controller, who brings it before the Board. If approved, the design is completed by the Director of Construction in consultation with the Director of Ordnance and Engineer-in-Chief. This is sent to the several members of the Board before being considered in Board meeting.

No change is allowed after final approval without the concurrence of the Board.

FIRST NAVAL LORD

Movements of the Fleet.
Organization of the Fleet.
Advises on maritime defense and strategi
General supervision of Intelligence Depa
Mobilization of the Fleet.
Complements of ships.
Gunnery training establishments.
Discipline.
Detail of Commanders.
Lieutenants to commands.
Naval attachés.
Leave.
Uniform.
Marines.
Hydrography.

Director of Naval Intelligence.	Admiral Superintendent of Naval Reserves.	Deputy General R rines.

T

or officially, th

L LORD.

d strategical questions.
nce Department.

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SECOND NAVAL LORD.

Manning of the Fleet.
Mobilization as relates to personnel.
Officers and men of steam reserve.
Training establishments other than gunnery.
Naval Colleges.
Coast guard.
Naval Reserve.
Appointments of Lieutenants (other than to commands) and Juniors.
Engineers.
Gunners.
Boatswains.

Deputy Adjutant eneral Royal Ma- nes.	Hydrographer.

Note.—Heads of branches are in several instances subordinate to several "Superintending" Lords, as the Director of Naval Intelligence to the Second Naval Lord in regard to mobilization of personnel; the Accountant General to the Junior Naval Lord in regard to certain allowances, etc.

ENGLISH NAVAL

THE BOARD OF ADMIRALTY,

or officially, the "Commissioners for Executing the Office of Lord High Admiral."

estions.
t.

SECOND NAVAL LORD.

Manning of the Fleet.
Mobilization as relates to personnel.
Officers and men of steam reserve.
Training establishments other than gunnery.
Naval Colleges.
Coast guard.
Naval Reserve.
Appointments of Lieutenants (other than to commands) and Juniors.
Engineers.
Gunners.
Boatswains.

THIRD NAVAL LORD, CONTROL

Navy Yards.
Material of Steam Reserve.
Ship and machinery design.
Construction and repair of ships and machinery.
Purchase and disposal of ships.
Loan of ships, tugs, etc.
Inventions relating to ships, machinery, ordnance, e
Navy Yard craft: *personnel* and *matériel*.
Navy Yard Police.
Navy Yard and victualling. Yard machinery.
Electric lights.
Naval ordnance, including material and stores.
Naval Store Department. Store expense, accounts
Corps of Naval Constructors.
Navy Yard employees.
Engagement of armed cruisers.

tant Ma-	Hydrographer.

Note.—Heads of branches are in several instances subordinate to several "Superintending" Lords, as the Director of Naval Intelligence to the Second Naval Lord in regard to mobilization of personnel; the Accountant General to the Junior Naval Lord in regard to certain allowances, etc.

Director of Construction (who is also Assistant Controller).	Engineer-in-Chief.	Director of Dock Yards (a civilian), who is charged with ship building, the maintenance in repair of ships and boats; the building and repair of steam machinery, and is responsible for economical performance of work.	Director of Na Ordnance.

AL ADMINISTRATION.

ONTROLLER.

inery.

rdnance, etc.

ery.

ores.

accounts of yards and ships.

JUNIOR NAVAL LORD.

Transport service.
Medical service.
Victualling service.
Hospitals and hospital ships.
Coal for the Fleet.
Appointments of Medical Officers, Paymasters, Chaplains and Naval Instructors, Assistant Paymasters, Clerks and Assistant Clerks, Carpenters, Writers, Ship Stewards, Nursing Staff.
Table money.
Compensations and allowances as regards the Fleet.
Debts.
Libraries.
Deserters' effects.
Salvage questions.
Savings banks.
Pensions.

CIVIL LORD.

Public Works.
Civil Staff.
Greenwich Hospital business.
Allowance to Ministers of Reli
Civilian Schoolmasters.

ctor of Naval nce.	Director of Stores (a civilian). All naval stores except coal for the fleet.	Expense Accounts (a civilian).

Director of Transports.	Medical Director General.	Chaplain of the Fleet.	The Director of Victualling (a civilian), Provisions and Clothing.

The Director of Works (an Army Engineer Officer.

JUNIOR NAVAL LORD.

).

Officers, Paymasters, Chaplains and Naval Instructors, and Assistant Clerks, Carpenters, Writers, Ship Stewards,

ces as regards the Fleet.

CIVIL LORD.

Public Works.
Civil Staff.
Greenwich Hospital business.
Allowance to Ministers of Religion.
Civilian Schoolmasters.

P

(Finan

lical Director ral.

Chaplain of the Fleet.

The Director of Victualling (a civilian), Provisions and Clothing.

The Director of Works (an Army Engineer Officer.

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PARLIAMENTARY SECRETARY.

(Financial Secretary, a Member of Parliament.)

Finance.
Estimates.
Expenditure generally.
Accounts.
Treasury and audit questions.

The Accountant-General (a civilian). Preparation of estimates, financial criticism, examination and payment of all claims against naval funds. Examination of Paymasters' cash accounts.	The Director of Contracts (a civilian). Purchases on duly authorized requisitions, stores, supplies, etc., and concludes contracts, except for ship propelling machinery and certain material pertaining to the office of Director of Works.

PERMANENT SECRETARY.

(Signs in name of Board.)

Charge of General Secretariat.

Correspondence.

Routine papers are disposed of by Permanent Secretary.

a. Such as require intermediate action or reference to render them sufficiently complete for decision by the Board.

b. Such as do not involve some new principle, establish a precedent, or occasion expense not provided for under existing regulations.

c. Such as do not involve any point of discipline or affect the movement or order to a ship.

All orders excepting those pertaining to routine work of the technical departments are signed by him in the name of the Board; all except routine correspondence is opened in the Central Secretariat and referred to every branch concerned; the answers to such are formulated in the Central Secretariat.

GENERAL STAFF.

Chief of the General Staff.

Assistant Chief
(a Flag Officer).

1st Section.

Office of Naval Intelligence.

2d Section.

Coast Defense.

Relations regarding Military subjects with Ministry of War.

Mobilization of troops of the Navy.

3d Section.

Details of every nature regarding the French Fleet.

Preparation of schemes of military operations.

Mobilization of the Fleet.

Bureau of Movements of the Fleet.

Armament and disarmament. Relations with ministry of foreign affairs. Instructions to Naval Commanders.

Hydrographic service.

Publication of scientific works.

Scientific material for navigation schools.

Cabinet Bureau.

Opening and distribution of dispatches. Correlation of work affected by many divisions. Telegraphic correspondence.

Ciphers.

Sending out of correspondence.

SUPERIOR COUNCIL OF THE NAVY.

The Minister of Marine.
Commander-in-Chief, Mediterranean Squadron.
Commander-in-Chief, Northern Squadron.
The Vice-Admirals who in this grade have been Commander-in-Chief at sea, and Prefet Maritime or Chief of General Staff.
The five Vice-Admirals, Prefets Maritimes.
The Chief of the General Staff.
The Assistant Chief of the General Staff, Recorder.

F

MINISTER'S CABINET.

Chief of the General Staff.
Assistant Chief of the General Staff.

Ten Officers of the Special Staff
Officers and three Officers of Marine Artillery).

CENTRAL FINANCIAL CONTROL.

Three Inspectors of Administration
and three Assistant Inspectors
(of the Commissariat Corps).

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sions.
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ce.

Law Department.

Litigation.

Questions of nationality and naturalization.

Gifts and legacies.

Examination of proposed laws affecting the Navy.

Private Secretariat of the Minister.

The examination of all questions involving expenditures.

1st Bureau.

Officers of the Navy.

Naval School. (This bureau covers all large questions concerning officers and the organization of this part of the service.)

2d Bureau.

Seamen.

Training establishments.

Advancement.

Disciplinary questions.

3d

Troop
infantry

ARD OF GENERAL INSPECTORS.

Five Flag Officers.
Three Captains.
A Commissary, Secretary.

INSPECTION GENERAL OF ARTILLERY.

A General of Division.
A Brigadier-General (of Marine Artillery).

**INSPECTION GENER
MARINE INFANT**

Three Generals of Divi

FRENCH NAVAL DEPART

MINISTER
(usually

CHIEF OF THE GENERAL STAF
(a F
(Aide to Chief

aff.

ff
rine Artillery).

CENTRAL FINANCIAL CONTROL.

Three Inspectors of Administration and three Assistant Inspectors (of the Commissariat Corps).

PERSONNEL.

Director
(a Flag Officer).
Assistant Director
(a Captain).

rivate Secretariat of the Minister.

The examination of all questions involving expenditures.

1st Bureau.

Officers of the Navy.

Naval School. (This bureau covers all large questions concerning officers and the organization of this part of the service.)

2d Bureau.

Seamen.

Training establishments.
Advancement.
Disciplinary questions.

3d Bureau.

Troops (marines) infantry.

4th Bureau.

Naval Constructors. Hydrograhpic Engineers. School of application Genie Maritime. Medical Corps. Chaplains. Technical Schools. Military Justice.
Police and justice at Navy Yards.
Naval prisons.

5th Bureau.

Pay, clothing and bedding.
Travel.
Pilotage.

6th Bureau.

Subsistence and Hospitals.

Provisions.
Preparation of same. Composition of rations. Administration of work; men for above. Administration of Hospital service.

CTORS.

INSPECTION GENERAL OF ARTILLERY.

A General of Division.
A Brigadier-General (of Marine Artillery).

INSPECTION GENERAL OF MARINE INFANTRY.

Three Generals of Division.

INSPECTION GENERAL OF THE CONSTRUCTION CORPS.

The Inspector General.
A Director of Construction.

ARTMENTAL ORGANIZATION.

STER OF MARINE

(usually a Naval Officer).

STAFF AND DIRECTOR OF THE CABINET.

(a Flag Officer).
e to Chief of the General Staff.)

DIRECTION OF MATÉRIÉL.

Director
(a Director of Naval Construction).

Assistant Director
(a Constructor).

1st Bureau.	2d Bureau.	3d Bureau.
Naval Construction. Presentation of plans of ship's machinery and of everything belonging to material, except artillery and small-arms. Must act in conjunction with Ordnance. Contracts for manufacture of articles in material and for experimental objects.	Public Works. Equivalent to Yards and Docks in U. S. organization, but covering somewhat larger grounds. Contracts for its own material.	General Supply and Shipments. Supply of the Ports, Indret, Chaussade and Naval Stations with material, excepting machinery, tools and special objects belonging to artillery, torpedoes and public works.

DIRECTOR OF ARTILLERY.

Director
(a Brigadier-General of Marine Artillery).
Assistant
(a Captain of Marine Artillery).

1st Bureau.	2d Bureau.	
Administration. Manufacture and supply of Artillery and Arms. Ammunition. Contracts for material special to this work.	Technical. Technical studies in all questions relating to Artillery.	Laboratory and Inspection of Artillery Works.

1st Bureau.	2d B
Funds. Payments and expenses exterior to France.	Centra ability.

INSPECTION GENERAL OF MARITIME WORKS.

An Inspector General of Roads and Bridges Corps.
An Engineer of Roads and Bridges.

COUNCIL OF WORKS OF THE NAVY.

Four Flag Officers.
Three Captains.
Three Generals of Marine Artillery.
One Colonel of Marine Artillery.
Inspector General of Construction Corps.
Inspector General of Machinery.
Director of Naval Construction.
Two Constructors.
Inspector General of Maritime Works.
An Engineer of Roads and Bridges.
An Assistant Constructor, Secretary.

N.

DIRECTOR OF ARTILLERY.

Director
(a Brigadier-General of Marine Artillery).
Assistant
(a Captain of Marine Artillery).

Bureau.	2d Bureau.	
inistration. ufacture and of Artillery rms. munition. acts for mate- ecial to this	Technical. Technical studies in all questions relating to Artillery.	Laboratory and Inspection of Artillery Works.

GENERAL ACCOU

Director
(Commissary Gener
Assistant Director
(a Civilian).

1st Bureau.	2d Bureau.	3d Bureau.	4th
Funds. Payments and expenses exterior to France.	Central Accomptability.	Accounts of Material.	Archi ries an tions.

COUNCIL OF WORKS OF THE NAVY.

Four Flag Officers.
Three Captains.
Three Generals of Marine Artillery.
One Colonel of Marine Artillery.
Inspector General of Construction Corps.
Inspector General of Machinery.
Director of Naval Construction.
Two Constructors.
Inspector General of Maritime Works.
An Engineer of Roads and Bridges.
An Assistant Constructor, Secretary.

BOARD FOR THE EXAMIN OF THE ACCOUNTS NAVAL WORK.

(A large mixed board on which
a Deputy, a Senator and a Co
State.)

ACCOUNTS.

ector
ry General).
Director
ilian).

CENTRAL SERVICE OF SUBMARINE DEFENSES.

Chief of Service
(a Captain).
Assistant
(a Commander).
Attached
(a Naval Constructor).

HYDROGRAPHIC SERVICE.

Chief of Service
(a Rear-Admiral).

Assistant
(a Hydrograghical Engineer).

4th Bureau.

Archives, Libraries and Publications.

5th Bureau.

Commercial Marine Rules for pilotage, shipwreck inquiries, etc.

6th Bureau.

Fisheries and Marine rights.

Manufacture of torpedoes. Technical and Administrative questions. Contracts.

1. General Hydrography.
2. The French Coast.
3. Charts and Archives.
4. Nautical Instructions.
5. Scientific Instructions.
6. Nautical Instruments.
7. Nautical Meteorology.

And an administrative Bureau, a civilian as Chief, in charge of contracts, purchases, etc.

EXAMINATION
UNTS OF
ORK.

on which there are
d a Councillor of

PERMANENT BOARD ON EQUIPMENT AND CLOTHING.

A Rear-Admiral.
Two Captains.
A Constructor.
An Inspector of Machinery.
The Surgeon-General.
The Inspector of Administrative Service.
A Lieut.-Colonel of Marine Artillery.

PERMANENT BOARD ON CONTRACTS.

Commissary General.
A Captain.
A Constructor.
A Lt.-Col. of Artillery.
Two Surgeons.
A Chief of Bureau and an Assistant Chief of Bureau concerned with Supplies.

A Board on Machinery and Heavy Tools, and a number of other boards less intimately connected with naval administration proper.

DENTAL ORGANIZATIO

MARINE

D DIRECTOR OF THE CABINET.

DIRECTION OF MATERIEL.

DIRECTION GENERAL OF
MARITIME WORKS.

specialists whose duty it is to handle it, makes a general store of general articles . . . and makes an accountant department covering the accounts of the whole as fully as now."

I have no doubt that the portion relative to the organization of the Navy Department will be well discussed by the members of the Institute, I shall therefore limit myself to a few words relative to—

1st, the purchase of supplies; and 2d, to their custody, care and issue.

My experience as head of a department at navy yards may be of some service in supporting that portion of the essayist's statement which declares that reforms of the present system are necessary.

PURCHASES.

It appears to me that the system in vogue for purchasing material leaves much to be desired. In a word, the system of open purchase is this:

Suppose the articles to be purchased are engineering stores. A Purchasing Paymaster receives from the Paymaster-General an approved requisition with orders to purchase. He prepares a list of articles and sends them to dealers. On the return of the proposals he selects the lowest bid and gives the order to supply. The dealer sends the articles to the General Storekeeper of the Navy Yard, who makes a call for inspection, and if the articles are satisfactory, they are passed and the purchase is completed. The bills are prepared by the General Storekeeper who certifies that the wares are received. The senior member of the Board of Inspection certifies that the articles have passed inspection and the Commandant approves. The bills are paid by the Purchasing Paymaster.

This all appears very simple and in many cases it works well. But in too many cases the articles are not satisfactory and are rejected. Then a notification is sent to the dealer to remove the goods and supply others. He may protest and write letters to the Storekeeper, the Purchasing Officer, and, perhaps, to the Commandant, the Chief of Bureau concerned, and to the Paymaster-General. Correspondence and the reference of papers to various officials follow. Other articles are sent in and rejected and more correspondence results. The articles may have been urgently needed and the interests of the Government suffer.

Why should such a state of affairs exist? Simply because the articles were not *purchased*. They were simply *ordered*.

Such a system would not be considered by a great corporation. A purchasing agent whose knowledge of the articles and the uses to which they are to be applied would be employed. Were this method followed in the Navy, there would be very few rejections, and delays would be avoided.

A paymaster in the Navy is qualified to purchase the stores pertaining to his special department. Only an engineer can, in the *true* sense of the word, purchase engineering supplies. An officer of the Construction Corps alone can decide what is required for construction work, and like-

wise an officer familiar with the requirements of the Equipment Bureau can best determine what is needed for equipment work.

If it were desired, volumes might be filled with examples to show the undesirability of the present system of purchases and the consequent injury to the public service. I will cite three that occurred somewhat recently at New York.

A piece of copper pipe was rejected seven times and then delivered by a manufacturer on a telegraphic order from Commandant within 48 hours.

A lowest bidder, after great delay, finally reported that he would be compelled to give a special order to have a valve manufactured. An officer was sent to New York to purchase it and the valve was delivered within two hours.

An award for a small electrical motor was given to a lowest bidder who agreed to deliver it within fourteen days. The motor was greatly needed. At the expiration of fourteen days he applied for information as to where he could purchase it.

It would probably be best to have one purchasing head at a station like New York where so much of the material for all navy yards is purchased. From what corps of officers this Chief Purchasing Agent should be selected is a question to be well considered. He need not necessarily be an officer of the Pay Corps, for a purchasing agent should not pay the bills. They should be paid by a navy paymaster, on proper vouchers, or by the Paymaster-General at the Navy Department.

The purchasing officer of a great railway corporation does not pay out money. The bills are paid by the treasurer. The head of a Navy Purchasing Office should have expert assistants whose duty it would be to select and order. All articles purchased should be inspected at the navy yards, as is now the practice.

It is a question whether the office of the Purchasing Officer should be at the navy yard or in the commercial center of the city near the yard. In either case it should have sample rooms attached containing standard samples.

CUSTODY, CARE AND ISSUE OF SUPPLIES.

As relates to the care, custody and issue of supplies, whatever may be the case at other stations, the work now imposed upon the General Storekeeper at New York is so great and of such a varied character that no one officer can perform it in a manner satisfactory to himself or to the service. I do not consider this a broad statement. I believe every one who has any knowledge of the subject knows it to be true. If this is admitted then the same would apply to all naval stations in time of war.

I agree with the essayist in that a general storehouse should be retained. If the General Storekeeper is to be an officer of the Pay Corps, he should, of course, retain the custody of provisions and clothing. The articles other than provisions and clothing in the general store should, however,

be more limited than many would imagine, unless they have considered the subject.

Previous to the issue of the Navy Regulations of 1893, certain articles of equipment were exempt from the General Storekeeper system. The Equipment Officer was the Storekeeper. The General Storekeeper had nothing whatever to do with them. The Equipment Officer made the same returns that the General Storekeeper made of the stores under his charge. The list of exempt stores was not then sufficiently extended. While there might have been a *question* as to whether a coil of rope or a bolt of canvas should be an exempt article, there should have been no question as to maintopsail reef tackles, coal whips, sails and awnings; and scores of articles might be enumerated which should then have been entirely exempt from the General Storekeeper system.

It is an error to suppose that there are now exempt stores. Certain stores under cognizance of the Bureau of Equipment are in the custody of Equipment Officers for care and preservation only. The wording of the Regulations has been interpreted by the Navy Department to mean that and nothing more.

Should storehouses be established at the navy yards under the various *Branches* at the Department, the stores should be absolutely under the control of heads of departments. If transferred from one station to another, shipments should be made by the heads of the departments who should also make requisitions, prepare invoices, and make periodical returns. The accounts, as is the case now, should be kept by the Paymaster-General.

I must again say that great care should be exercised in establishing the list of stores to be placed in the charge of the General Storekeeper. The tendency would be to extend the list to such an extent as to again overburden that official with work.

There are certain stores which require expert knowledge in inspection, which should remain in charge of heads of departments from the time of receipt, as, for example, paints and oils. It may be said that regulation will provide for the inspection by officers having expert knowledge. The same might be said of insulated wire and other electric material, of library books and sounding machines, of rifles and revolvers, of indicator sets and steam gauges, which undoubtedly should be exempt.

Whatever supplies the General Storekeeper has should be classed as General Stores, and the terms Engineering, Construction, Equipment, or Ordnance Stores should never be applied to them. The heads of departments at navy yards should have no relations toward them whatever, but should draw on them when necessary.

The changes proposed in the method of purchase, and perhaps in the custody, care and issue would require legislation. That would naturally be included in the legislation necessary for the reorganization of the Navy Department.

Lieut. E. F. QUALTROUGH, U. S. N.:—The paper on Naval Department Organization by Commander Chadwick treats of a subject of vital importance to the service and to the country.

I was fortunate enough to have about four years' experience in navy yard work, principally in ordnance and equipment. A portion of this period was under the old system of administration, and more than one-half of it under the so-called new or general storekeeper system.

After a fair trial of the latter method, it was apparent that, in the case of special technical stores and materials, no intelligent supervision was practicable, and the responsibility for delays and defects in outfitting vessels could rarely be properly placed. It was also plainly to be seen that in cases of emergency, requiring despatch, it would be necessary to abandon all the salient points of the system and practically return to the one in use before.

The consensus of opinion among those officers in a position to judge seemed to be that the general storekeeper system, as introduced, while providing for an elaborate method of accounting, was very expensive, cumbersome and slow. In fact, the majority considered it as a worse system than the one it superseded in most respects.

The scheme proposed in the paper under consideration, seems to be in line with the best modern practice abroad, and to provide a system which will work well under any circumstances.

I desire to express myself as being heartily in accord with the ideas advanced, and hope they may receive such united support from the service that Congress will be induced to enact them into law.

Naval Constructor D. W. TAYLOR, U. S. N.:—The question of departmental organization for the Navy brought forward in Commander Chadwick's interesting and timely paper is a most important one, and it is to be hoped that the paper will bring out a full discussion.

The organization proposed does not seem to me to be an improvement upon the present one as regards the important question of material. The changes proposed consist in brief in establishing two additional bureaus or "branches," and placing all the technical bureaus under one head, a "flag officer of large navy yard experience." There appears no necessity for such an official to intervene between the responsible heads of branches and the Secretary, with whom all responsibility ultimately rests. With the arrangement proposed either the Secretary or the "Superintendent of Material" would be a mere figurehead as regards the vast majority of matters connected with material.

The point is well made that with the arrangement proposed the Secretary would be relieved of much work which "under any proper system need never come before him." It is a fact that at present many minor matters pass before the Secretary, but it is only of late years that this has been the case. The policy of Secretaries Tracy and Soley was one of cen-

tralization. They concluded that they preferred to pass themselves upon many matters which formerly had been left entirely to the bureaus. Any Secretary who considers his time too much taken up with petty detail can free himself of it at once by again turning such matters over to the bureaus. This would, I believe, be found more satisfactory than the proposed creation of a Superintendent of Material.

If I am correctly informed, something more than twenty years ago, a gallant and distinguished flag officer, who had more than once received the thanks of Congress for distinguished service, held a position where he was *de facto*, if not *de jure*, in possession of most of the power and authority of the author's proposed Superintendent of Material. The results of this experiment were not such as to justify the permanent adoption of such an arrangement.

The Naval Council proposed seems superfluous. The corresponding individuals in the present or any other organization will be always at hand to advise the Secretary. He can consult them individually or collectively as he sees fit. For my part, I believe that the "multitude of counsellors" referred to by the wisest of men were not considered as forming a board.

As a result of comparatively recent experience with the Advisory Board, capable and able as it was, I believe few officers will consider that there is any demand or need for the Board on Construction proposed by the author, which is practically the Advisory Board over again.

The changes proposed by the author in the matter of stores at navy yards are, in my opinion, very desirable. If the care, custody and accounting for material at a navy yard were vested in the head of the department whose bureau has purchased the material, and who will use it, there would be a great reduction of clerical work and saving to the Government.

If the workings of the present system were such as to relieve the head of department of all care regarding material, so that he had but to ask at the store for what he wanted in carrying on his work, no one would advocate it more strongly than I, but in practice this is not and cannot be the case. The working department has to do all the technical and much of the clerical work in connection with supplies, and has to keep anxious watch upon the store to see that its supplies are kept up. There is no reason why it should not do all the clerical work, thus saving a great deal. Let us take one instance among many. Under the present system, the head of a department at a navy yard needing certain supplies, after satisfying himself that they are not in store, makes a request on the General Storekeeper to make requisition for the supplies. The "request for requisition" must be in the exact form of the requisition itself. Upon receiving it, the General Storekeeper copies it *verbatim literatim et punctuatim* upon a printed form, and it proceeds upon its tortuous way. With the ordinary duplicating devices, ten or twelve copies can be made with little more labor than is involved in making one, and there is no reason why the de-

partment concerned should not prepare all copies needed in the first place, saving the General Storekeeper unnecessary and expensive copying.

The objections to the principle of the present system are fundamental, and may be indicated in brief. The procuring, handling and issuing of supplies for a working department is so intimately connected with the using of the supplies that it cannot be satisfactorily carried on at second-hand as an entirely separate thing. Technical knowledge is essential, or absurd mistakes will occur as in a recent instance told to me where the armor of a ship, as it happened to consist of steel plates, was charged against the ship at the same price, per pound, as the other steel plates which made up the structure. As steel armor plate costs some six or seven times as much as structural steel, the result was an error of some two hundred thousand dollars or so in the cost of the ship as reported.

The objection to the control of supplies by the head of department is the supposed lack of accountability and inaccuracy of returns.

It was supposed that when the present system was adopted, there would be no more discrepancies between the books and the supplies on hand. As a matter of fact they do occur. When they happen to be discovered a Board of Survey is called to investigate the matter. The General Storekeeper opines that the head of the department concerned has managed to get hold of material without proper requisitions. The head of department strenuously denies this, and casts reflections upon the accuracy of the General Storekeeper's books, which are hooted at by that individual. The Board is unable to fix the responsibility, since either one of two individuals, or their predecessors back to the third or fourth generation, may be guilty. Finally, the Board reports that it can fix no blame upon any one, and recommends that the missing goods be charged to Title W. The bureau concerned is unconcerned, and recommends that the disposition recommended by the Board be approved. The Paymaster-General authorizes it and the books are straight once more. Title W. never complains.

The author proposes to hold the heads of departments to strict accountability with periodical stock taking, and frequent inspection of their accounts by officers acting under the Paymaster-General. This could be done without difficulty, and would result in much greater accuracy and "accountability" than the present system. The question is not a small one, and a detailed discussion would be out of place here.

There is one feature of the present system not touched upon directly by the author which is very objectionable. This is the turning into general stock, immediately upon the close of a fiscal year, of all supplies purchased from the current annual appropriations of the various bureaus for the year. The object, of course, is to prevent unnecessary purchases and the accumulation of stock. This object has been accomplished only too well. Stocks of supplies are depleted far below what should be, and material is purchased piecemeal at greatly enhanced expense.

Each bureau has a separate and definite appropriation, and it profits it more in the end to purchase piecemeal at high prices than to purchase wholesale at low prices, find its purchases gobbled up in a few months by another bureau (after the first of July), and then in a few months more purchase the same things over again. No material should be turned into common stock unless it has been at least a year in store.

It is hardly fair to criticise the scheme of organization proposed by the author without suggesting a substitute. Considering that the ultimate object of a navy is war, and that no organization can be sound which would have to be given up or seriously modified if we went to war to-morrow, we must consider the fact that our present organization has survived and indeed was partly adopted in "the stress of war times," a powerful argument in its favor. There is no doubt, however, that the division of the technical work of the Navy between so many different bureaus tends to produce objectionable clashing and friction.

We are too, I believe, the only people who entrust the design and construction of the guns, gun-carriages, engines, etc., to sea-going officers whose work at sea has in many cases little or no connection with their work ashore. Far be it from me to decry the value of experience at sea for any one connected with the Navy, but I think the Navy would be better served if the designing engineers and ordnance officers did no sea duty after a certain age, say in the early thirties. By that time they should have had sufficient experience at sea to last them until sixty-two, and their bent of mind and capacity for permanent shore duty would have fully disclosed itself.

Many officers think that there should be but one corps of constructors and designing engineers, and some consider that all the technical work ashore now divided between the five bureaus of Construction, Equipment, Ordnance, Steam Engineering and Yards and Docks would be better done if put in charge of a single corps.

For my part, I consider that the arrangement best suited to our needs and conditions would be one where there was a single shore-staying corps in charge of all the technical shore work, this corps being filled up from the bottom by sea-going officers not over thirty-five.

It would be difficult and probably impossible under present conditions to inaugurate such an arrangement, but I think it would prove a satisfactory one. While the permanent corps would be in charge of all technical matters, I would have a certain amount of the subordinate work done, as now, by the younger sea-going officers, those of proved capacity and aptitude to fill the vacancies in the permanent corps.

Naval Constructor FRANCIS T. BOWLES, U. S. N.:—After an experience of four years in the Navy Department, on duty closely associated with the principal bureaus and the Secretary's office, and of eight years as a head of department in an active navy yard, I am convinced that the

best organization of the Department of the Navy will be that which will secure the most efficient administration of the building, equipping and furnishing supplies to ships, or, in other words, the best management of navy yards. If the latter are well managed, contract work is naturally included in the same system.

Of the four natural divisions of naval administration, the first place is properly given by the author to *matériel* to which is devoted by far the larger part of the cost, labor and personnel of the Department of the Navy.

The scheme of organization suggested by the author, when judged by the standard here set up, will be found to result in an aggravation of the difficulties now existing. It complicates and diversifies where it should combine and simplify.

For example, the ideal organization of an establishment for doing work, such as a navy yard, is that it should be in that respect under the control of one manager, one practical head, or technical superintendent, separate from the military control of the post while in the execution of his duties. Under such an organization the Commandant would be the military commander of the post, the superintendent would have entire control and responsibility for all works including maintenance and improvement of property. All stores should be in his custody and control. The Bureau of Supplies and Accounts should in the same official exercise the functions of pay officer, purchasing officer, accountant and auditor. All accounts of stores should be kept by the General Storekeeper, but the custody and responsibility for all stores, except provisions and clothing, should be with the superintendent, to be enforced by frequent inventories and regular auditing of all the superintendent's returns of issue and expenditure.

At present in navy yards there is much greater organization than is necessary, the clerical forces and laboring forces are duplicated in doing the same class of work under different bureaus. Much useless expense could be saved and greater efficiency and rapidity of work could be obtained if all were done under a single management and under one organization.

In order to render this practicable, the organization of the Department at Washington must lend itself to it by a similar arrangement, whereas, on the contrary, the author's arrangement further complicates the existing system by adding to the number of heads, or chiefs, each one of which can give orders to the corresponding department of the navy yards.

The author leads us to understand that the older naval administrations of Europe are those which we should look to for example, and that his scheme is based upon them, whereas a comparison of his diagram with those given of England and France shows many extraordinary departures from the almost perfect symmetry of the latter. These departures, in many respects absurd and on purely reasonable grounds indefensible, display a general motive to magnify the authority and control of the military

officers over the subjects, a knowledge which least adds to their naval efficiency.

For an organization in which *correlation* is to be secured above all, attention is called to the remarkable heterogeneous group of subjects classed under the Equipment Branch as follows: Electrical work, coal for ships, rigging, cordage, sails, anchors, chains, navigational and scientific instruments, for use afloat; specialized material, accounts.

The very wording of the group renders it ridiculous. Who can explain why, in an ideal system, coal for ships should be separated from general stores? or why it should be grouped with electrical work? There is not a single item on the list which justifies the existence of the Equipment Branch. There are various ways in which the subdivision could be made without this branch which are better than having an unnecessary and useless bureau cumbering the transaction of business and calling forth an extra supply of *correlative* energy.

The best means of correlation among naval officers is through a common civilian superior, such as the present Assistant Secretary and the Secretary of the Navy. The author's scheme seems to provide for an organization which would run quite smoothly without annoying these officials with knotty nautical points, but such a one, carried out in the spirit evinced in this article, would soon prove disastrous to the naval service.

Lieutenant J. B. MURDOCK, U. S. N.:—The article of Commander Chadwick is, in my opinion, one of the most valuable before the Naval Institute for many years. Although the present generation of officers of the Navy have been brought up on the bureau system its defects are very apparent, and the organization required by law is commonly recognized as one of the most serious defects impairing the efficiency of the Navy. The position of Commander Chadwick as Chief of the Bureau of Equipment, together with his previous services as Naval Attaché at London and Chief Intelligence Officer, have given him rare opportunities both for information and criticism.

The paper can call for no criticism from me, but I am glad, in availing myself of the opportunity to comment upon it, to state some of my reasons for agreeing with its conclusions.

There is frequently a strong tendency, within as well as without the service, to forget that the Navy necessarily is and should always remain a military organization for military use. Steam will render future naval movements more rapid in execution than formerly, while the telegraph will render practicable combinations of fleets and strategic operations heretofore unknown. The man-of-war of the future must be always ready for sudden calls for service to be of any use whatever. This condition is, however, more difficult to fulfil than ever before, on account of the mechanical complexity of the ships themselves. Filled as they are with all varieties of

machinery which is, moreover, specially subject to deterioration, keeping a ship in order is a most difficult problem, and with the best of care accidents and wear and tear will eventually necessitate repairs that cannot be made aboard. When this occasion, or its kindred one of deficiency in stores, requires a ship to go to a navy yard, the prime necessity of returning the ship to active service as soon as possible calls for prompt and efficient action on the part of the navy yard administration.

A ship at sea is a military unit under the provisions of the Navy Regulations. The captain is the fountain head of all authority, and is given full control of everything connected with the care, administration and general efficiency of the ship and personnel. With this plenary power is associated the idea of full responsibility, and this association enables military efficiency to be secured.

When, however, the ship reaches a navy yard all is changed. The commanding officer who has thoroughly informed himself as to the needs of his ship as regards repairs, changes or supplies, now loses all control over them, and his duties are confined to writing letters and signing requisitions. The unity of command which he has lost is not assumed by anyone else. No *one* official, except the Secretary of the Navy himself, can take full charge of the ship and give the orders necessary for the supplying of all her needs. The Commandant of the navy yard on whom, as the senior officer present, the execution of these duties would naturally devolve, is almost devoid of original authority, his duty consisting mainly in forwarding papers to the bureaus of the Navy Department and in executing orders received from them. Boards of Survey multiply, reports are made and passed back and forth, papers accumulate, letters are forwarded and returned gathering endorsements at every stage, and gradually, one by one, the chiefs of bureaus approve of the repairs requested in their respective departments, and work commences. If supplies are necessary, requisitions are sent in and passed between the head of the department concerned, the General Storekeeper and the Commandant. New requisitions are next made out for supplies not on hand and are sent to the Department; if approved, they are placed in the hands of the Purchasing Paymaster who issues proposals, or if emergency is not claimed, the Bureau of Supplies and Accounts advertises for proposals, time being lost at every stage. The award is given to the lowest bidder, who frequently fails to inform himself of just what is needed and has his supplies rejected by the next tribunal, the Board of Inspection, in which case the whole cumbersome process of bids, proposals, etc., is commenced again. Finally, the stores are received aboard ship, it may be several months after the original requisition was sent in, and are found to be of an inferior quality to what could have been purchased in a few hours at the same price, if an officer could have been authorized at the commencement to go and get what was needed.

The above is no exaggeration, as every officer having navy yard experience well knows. The moment a ship reaches a navy yard all unity of control is gone and it is turned over to what has sometimes been called a "business system," although the term is almost an insult to our civilization. In business, as in military matters, the main requirements are celerity and success, the saving of time being as valuable as the saving of money. Authority is given to subordinate officers to act within well defined spheres, and each is held to a proper responsibility for his actions. It is not considered good business to multiply papers of any kind or to divide between several persons the responsibility which should rest on one only. Different departments are organized by the proper subdivision of work, but in each every person is responsible to some one above him, who in turn accounts to some other superior, all chains of responsibility finally converging in the chief authority. This system is business-like, it is military, it is the one that experience has shown as best adapted for securing quick and rapid action.

As I understand Commander Chadwick's plan, it strikes at the root of the difficulty in our present navy yard administration by throwing under the charge of one bureau officer, the Superintendent of Material, everything connected with the building, equipping, repairing or supplying of ships and naval stations. I assume that he would be nominated by the President and confirmed by the Senate, like the present chiefs of bureau. His duties would be mainly executive, but as no one man could find time to attend to all the details of the work, and no officer of the service could be an expert in all the branches of construction, equipment, ordnance, and steam engineering under his charge, assistants would be necessary, each having immediate supervision of one branch. These officers, I assume, would be ordered to their duty by the Department, and each in his own sphere would act under the orders of the Superintendent of Material, and be responsible to him directly. At each navy yard the Commandant is the representative of the Superintendent of Material, having heads of departments as his assistants, and in his hands is the whole matter of repairs and supplies under general instructions from the Superintendent of Material. Under this system, the commanding officer of a vessel arriving at the yard could present all matters concerning his ship to the Commandant, who is entitled to assume full control of the work and responsibility. The question as to the amount of authority for repairs which should rest with the Commandant, seriously affects the efficiency of the system, and, in my opinion, the best results would be obtained by giving him, as the representative of the Superintendent of Material, wide discretionary power to act under general instructions, referring only such matters to the Department as may in his opinion be necessary, although keeping it fully informed of everything done. Such is the practice in business circles. There are very many manufacturing establishments in the country which employ more

workmen and handle more material than any of our navy yards, and the common practice is to give the head official of the works full control under general directions from the general manager or board of directors.

The Commandant, in addition to his duties in charge of all repairs and supplies, will of course have full naval command of all under his orders, and will be subject to directions from the Chief of the Bureau of Personnel and to the General Staff. There seems to be no necessity for his having any direct official relations with the Paymaster-General except in the one item of pay of employes, all questions relating to purchase or expenditure of material being in charge of the Superintendent of Material.

The whole matter of supplies and accounts is at present in a most unsettled condition, and most officers are satisfied that it would be completely inadequate in time of war or sudden emergency. In the attempt to remedy the defects of a previous system, it is almost certain that we have fallen into a worse one. At first sight it might seem that the principle of unity of management already advocated would favor a system like that now existing in the Bureau of Supplies and Accounts, by which everything in connection with purchases is placed under the control of that bureau. Theoretically this is admirable; practically it leads to endless confusion, from the fact that the management of supplies is entirely removed from the control of those who need them and use them, and from the bureaus which by law pay for the stores and are required to exercise supervision. If the Bureau of Construction could build or repair ships without buying material, or the Bureau of Equipment could equip them without purchasing supplies of any kind, each being responsible only for work done, all purchases might be made by an outside authority. All work on a ship requires, however, the careful selection of material, as well as the supervision of its installation, and the two cannot be separated without disastrous delay and inefficiency of management. The different branches should therefore be in full charge of their duties, the details of purchase being largely turned over to the branches needing the supplies. The arrangement proposed by Commander Chadwick returns to the old system of separate stores, purchases being made by a purchasing paymaster, but provides for a complete supervision of store accounts, with much less complexity and more efficiency than now exists. All requisitions would be made on the Superintendent of Material, and on his approval the Commandant would order the purchase by the Purchasing Paymaster, all questions as to quality, specifications, etc., being referred to the navy yard representative of the branch concerned. The payment of bills and the transfer of money is of course under the charge of the Paymaster. The stores once purchased should be transferred to the branch store at the proper navy yard, and invoiced to the officer in charge of the branch, to be expended by order of the Commandant for such purpose as may be designated. Equipment stores would thus be invoiced by

the equipment officer of the navy yard to the equipment officer of a ship, the only change from the old system being that a copy of every invoice would be furnished the Paymaster-General who, having nothing to do with the custody or transfer of stores, would be able to keep account of all purchased, transferred or expended. This would secure the necessary accounting for property without making the important matter of supply of material entirely subordinate thereto.

The greatest obstacle to the prompt transaction of purchases is found in the provisions of the Revised Statutes alluded to by Commander Chadwick. The one feature of Art. 3709 which enables army supplies to be procured promptly is that "when immediate delivery or performance is required by the public exigency, the articles or service required may be procured by open purchase or contract at the places and in the manner in which such articles are usually bought or sold, or such services engaged between individuals." The provisions of the statutes in relation to purchases for the Navy are, on the contrary, such as to interpose delay and to prevent all direct action tending to promote the securing of any particular class or quality of supplies by selection or direct purchase. It is impossible to exactly specify articles in common use, so that there may be no uncertainty in procuring them by advertisement. Dealers in supplies would prefer direct purchase and speedy payment in preference to the complicated system of proposals and bids, too frequently followed by rejection by the Inspection Board. The right should be given by law to the Navy to make purchases in an emergency in the same way as would be done "between individuals."

The present system of obtaining supplies is defective in celerity and reliability, and is inaccurate from its excessive complexity. So long as the affairs of several distinct bureaus are largely under the control of the Bureau of Supplies and Accounts, as well as of their own bureau chiefs, nothing but delay and confusion can result. With the placing of navy yard control under one supreme head, it will be possible to so simplify the purchase and control of stores as to admit of the unification of accounts of the service, now vainly sought in another way. The plan of making one bureau purchase, supply and transfer all stores for six others, independent and not in sympathy with it, inevitably aggravates the lack of cohesion and the difficulty of securing unity of action, which are the vital defects of the bureau system.

The adoption of Commander Chadwick's plan would establish responsibility throughout the service, and by a proper division of work would enable every detail of naval administration to be carried on with as much celerity as is consistent with the proper supervision of work and material, and would enable the same number of ships in commission to do much more work, through the facilitating of repairs and the saving of the time now wasted in securing action under the bureau system.

Commander F. M. BARBER, U. S. N.:—Commander Chadwick's plan is evidently the result of much study of a most complicated subject, and it appears to me to present a practical scheme. I have heard it stated that the bureau system, being simple to understand, was well enough adapted to our wants, and having stood the test of the civil war, was not lightly to be thrown aside; but it has a kind of simplicity which always leads to complication, and I doubt if it would stand the sudden stress of a foreign war except in so far as the mere supply of material is concerned, and even that could not be done with our present clumsy method of purchasing; as for planning a campaign or organizing a system of defense, there is no provision for it whatever in the bureau system.

In addition to simplifying real administration and fixing responsibility both in war and in the every day affairs of the Navy, the essayist's plan presents other advantages. As we are organized at present, the position of "Chief of Bureau" is the highest complimentary shore duty to which an officer can aspire, and it is the only position in which one can have much hope of success in pushing to the front the ideas which he may have been accumulating and nursing for years, ideas by which he may hope to leave his mark upon the service, and for which opportunity seldom offers at sea in time of peace. In this plan the Chiefs of Bureau lose a certain amount of their importance as the consituted advisers of the Secretary (though they can still be called upon if he desires); but they retain all their practical power as executive heads, and in addition there are created the offices of "Superintendent of Material," "Chief of General Staff," "Chief of Bureau of Personnel," and "Senior Member of Board on Construction," all of which may well be the legitimate object of ambition for older officers, while other positions of real importance in the General Staff and the Board on Construction (where they can make themselves felt) are open to younger men who would otherwise have their heads under water in subordinate positions in a navy yard or bureau.

By our present system, also, there is no body of men at the Department whose business it is to deal with inventions or new ideas. An invention or an idea now comes to the Department either from an officer or a civilian, and it is referred by the Secretary's office to the bureau to which its function pertains. In due time (for of course it can never take precedence of routine work), it arrives on the desk of an overworked chief, and then if he is not too busy or too prejudiced, something may be done; but at best, it is almost certain for a variety of reasons to be very unsatisfactory to the inventor, and to the chief also, for if the inventor has influence, the rejected invention may come back three or four times. This latter is a consequence of our political system, and there is no remedy for it. I know from personal experience that the mass of idiotic inventions and ideas with which the Department is flooded is almost inconceivable, and the grains of wheat are most infrequent in the bushels of chaff. Still there *are* grains, and as

the U. S. has the reputation of being the most inventive nation in the world, and the statistics of the Patent Office show the singular fact that all radical improvements in well established lines of manufacture are made by people who know nothing about the lines whatever, I think that no *one* man should have the power of determining whether an invention or an idea shall be investigated by the Navy Department or not. It appears to me that in this new plan the Board on Construction, like the Board of Works in France, or some minor board under its orders, could easily investigate such subjects with more satisfactory results than obtain at present to all concerned, both inside and outside the Department.

I have only one criticism to make upon the paper, and that is with regard to the "general" and "branch" store arrangement. The plan proposed is an improvement on what we have at present, but I would go a step farther and abolish the general store. I have been told by older officers, that by the end of the civil war each department at our principal navy yards was almost completely independent of every other, not only in the matter of stores of every description, but even down to carts, horses and oxen. To my mind celerity in navy yard work will never be obtained in any other way, and in war time celerity is vital and delay admits of no excuse. Even since the war I remember, in the early days of the torpedo station, that Captain Matthews included and approved on the same ordnance requisition a clothes wringer for wringing gun-cotton, and a yoke of oxen for ploughing, and yet the official heavens did not fall, nor the sun refuse to shine, nor the stars wander in their course, as would be the case were the same enormity to be committed nowadays. We all know that war is the season for extravagance, and peace the season for red tape, but I think that the war system is the one to work with and regulate by a proper system of financial control carefully studied out in time of peace.

Lieutenant S. A. STAUNTON, U. S. N.:—Commander Chadwick's able paper brings forward questions of administration reform, whose importance has been long recognized even by those officers who have had little to do directly with departmental or navy yard methods of business. In fact, these questions have not infrequently been forcibly pressed upon the reluctant attention of the most unobservant.

The business organization and division of duties proposed by Commander Chadwick are logical and should, if made effective, do away with many of the sources of weakness and confusion which now exist.

Systems varying somewhat in their details from his might be equally logical and successful. There need be nothing dogmatic in the assignment of subordinate branches of naval business, provided, always, that the development of the scheme follows generally the lines laid down in its fundamental principles, which should be practical and sound. This, I take it, is the essayist's main object—to call attention to the basis upon which good organization must rest.

Those features of his scheme which provide for reconciling the differences between the several officers of Construction and Equipment, and for providing the Secretary of the Navy with a formal and responsible professional opinion are worthy of especial attention.

The Board on Construction is clearly a present necessity. It should be composed of officers who are not connected in any way with the bureaus, and who would therefore be critical in their scrutiny and independent in their expression of opinion. To this board should go all plans for new ships, and for all important alterations and repairs—to be carefully examined and formally endorsed before they go to the Secretary for his final action. Had such a board continuously formed part of the Navy Department during the past ten years, we probably should not have spent large sums of money to remedy insufficient stability in some of our new ships, and we should have been spared grave doubts as to the safety of others when brought to the ultimate test of action.

It is no reproach to the members of a construction corps to submit their designs to the check and correction of sea-going professional men. Speed, especially in ships of a certain class, has been in recent years more discussed and boasted of than any other quality; and has been, when obtained, more easily placed in evidence. A constructor, with this idea dominant, naturally fines his lines to the limit of safety and diminishes stability to obtain speed, and in recent cases it has been shown that a constructor's idea of safety might be one which no sea-faring man would accept. Whatever may be the value of speed (and no one depreciates its tactical importance) no naval officer who expects to command and fight a ship will make any sacrifice of stability to speed. With a protective deck which, under the ordinary circumstances of action, will probably keep all the water that enters a ship above her center of gravity, it is impossible to know precisely what will happen in the event of serious injury to the water-line; and therefore stability, if it errs at all, should go to the side of excess. A ship must stay upright as long as she floats. Nor would the attention of such a board be wholly given to the sea-going qualities of a vessel. Other matters—tactical questions—would be considered. Extreme views would be modified, and the result would be better ships than those built from designs in which extreme views have been allowed to prevail.

This board, as well as the Naval Council, a Chief of Staff, or any other authority, collective or individual, in which are reposed the duty and responsibility of furnishing professional advice and suggestion to the Secretary of the Navy, should have its functions defined by law. The law should be mandatory as to the occasions when recommendations should be given, and on all occasions such action should be a matter of formal record. Then the Secretary of the Navy, if he approves the action of a board or council, has a powerful and responsible professional opinion behind him; and if he disapproves it and decides otherwise, he clearly

accepts the whole responsibility. This gives to professional opinion its full scope, and couples therewith a full measure of responsibility.

The methods of naval business—and everything takes its spirit and form from the central administration—should be simple and direct, and flexible enough to meet emergencies. Whether the various checks now established are efficient or not in preventing losses of certain kinds I do not know; but I know they do not avoid mistakes, and that they are not efficient in securing despatch. I think it requires something like fifty signatures to make a petty purchase. Such a multiplicity of papers and certificates is likely to degenerate into a mere formality. Some one must ultimately be trusted, and the faithfulness of government servants depends more upon *esprit du corps* and the traditions of their service than upon a multiplication of business forms.

In war, or preparation for war, our system would at once break down, and the responsible officials would make the necessary contracts and purchases at their discretion precisely as men at the heads of great corporations habitually do. Even in time of peace it is frequently necessary to do the same thing and let the papers follow. Some years ago the executive officer of a ship lying at the New York Navy Yard told me he had just had some work done on the bower chains. He said that the regulations required them to be invoiced to the General Storekeeper of the yard, who then invoiced them to the Equipment Officer for repairs; after which the Equipment Officer invoiced them back to the General Storekeeper, who then in turn invoiced them back to the ship. My friend said: "It will take two or three days for all these papers to go through the proper channels; but I got the chains out on the wharf this morning, they are repaired and back in the lockers although the first invoice is not yet made out." And such things are continually happening. The papers are always in arrears. The senior permanent member of the Board of Inspection at one of our principal navy yards told me that there had actually been sent to him for a certificate of examination and acceptance a bill for fresh provisions, supplied to a ship a month before, and of which he had no knowledge whatever. He refused to sign it, and thereby caused annoyance.

I believe that some of our most cumbrous business methods are dictated by Treasury requirements based upon law, and could not be changed without the sanction of law. But this sanction ought to be forthcoming. A regulation which is not intrinsically practical and sound has no vitality, and it is not well that any regulation in a military service should lose this quality.

Commander CHADWICK:—I regret that the military phase of the scheme put forward is not more fully touched upon than it has been by those discussing the paper, as this, of course, is the primal question in any proper scheme of naval administration.

That the establishment of the military part of the administration into a

General Staff and a Bureau of Personnel with a division of duties as proposed is sound, can, I think, be not contravened. It is in full accord with the consensus of all opinion as set forth from time to time within the last ten or twelve years, and in accord with the practice of at least four of the most important military nations.

The suggestion of Captain Taylor's that the War College should come under the General Staff is, of course, a sound one, and should not have been omitted from the list of duties of that Bureau.

The shipbuilding and financial aspects of the question present grounds for greater differences of opinion, and while convinced of the soundness of the principle laid down, I am quite ready to concede that there may be points of detail in which it can be improved; *e. g.* whether the Superintendent of Material be a line officer, a constructor or a civilian does not affect the principle. The establishment of one superintendent of technical work in a yard *and* his entire separation from the control of the Commandant, as is proposed by one able officer, I regard as an impossibility. Were it merely a question of building ships or fitting for sea ships not in commission there might be a chance of its working, but much the greater part of our work is on ships in commission and the military and technical are so interlaced that a military head is a necesity; but that there should be one technical head I agree.

The experiment entirely separating the military and technical heads had a long trial in France, beginning under Colbert, when the *Intendant* or *Commissaire* was omnipotent in the naval ports, and the military branch of the service had nothing whatever to do with the Navy but sail and fight the ships. This lasted for eighty years without any change whatever, and though greater or less changes took place thereafter, dating particularly in 1765 and 1776, it was not until 1800 that the present French dockyard organization may be taken to have been fully established. The School of Construction was founded at Paris in 1740, and the title of *Ingénieur* and the hierarchy of the corps of constructors established in 1765. The regiment of Artillery of the Colonies was created in 1786 and ordnance placed in the control of officers of this corps, and it remains to-day separated from other material as to control. The surveillance of the works of the Navy in France was thus by a natural process of evolution differentiated into its present form. There is a Superintendent of Material (*Directeur du Matériel*), ordnance, however, as just mentioned, being excepted from his superintendence. This officer is sometimes an admiral, but more frequently and latterly (for the past eleven years) always a constructor.

The Corps of Construction in France (the *Génie Maritime*) is a large and very powerful body, all the more influential from its solidarity with the other graduates of the Polytechnic School; as those of the *Ponts et*

Chaussées, etc. I can see no reason why, now that we are arriving at such a corps, the Superintendent of Material should not, sometimes at least, be a constructor. The French organization is undoubtedly a good one, but it is, *pace* the critic, more complex in actuality than the one I propose. If one may so say, it is over-organized.

As to differentiation of duties, I believe in differentiation as far as it can be carried; the farther the better, so long as the heads of the branches are subject to one particular supervising head. We have certain work of various and specified sorts to do; and combine, separate, shift them as you will, the differentiation of duties will and must exist, whether nominally or not; the personnel required to execute the duties will also practically remain the same. A ship must be rigged and there must be riggers; her ordnance, ammunition, anchors, chains, provisions, electric outfit and all the other vast complexity of material looked after by experts in their several departments, and whether the supply of these be nominally resolved into three branches or six, the necessary number of divisions, with their varied personnel and varied duties, will and must continue to exist. There is no good administrator who does not divide the duties of his department to a greater or less degree among subordinates whom he holds responsible for the work over which they are placed. We do not attempt to hold the same persons responsible for ammunition and torpedoes in the one branch; nor the same persons for compasses and chronometers in another. Coal, which may be regarded as a matter of military supply as much as ammunition, cannot be furnished at haphazard, and any view of the subject which supposes that anything is gained by dealing with matters in less detail than that laid down appears to me a short-sighted one.

I would say that no "experiment" was made "something more than twenty years ago" in which a flag officer held a position "where he was '*de facto* if not *de jure*' in possession of most of the power and authority of the author's proposed Superintendent of Material." The experiment was quite a different one.

I would reiterate that branches are confined, in their correspondence with navy yards, to absolutely routine work. No one man could possibly look after the signing of all papers relating to such work.

My paper has been written with the idea that a question of immense importance might have at least an airing. It is one which the service has never discussed to any extent though of such primary import. As already said, the scheme may be open to many improvements. We could, for instance, go a long way possibly towards the employment of permanent civilian officers, as in England and other countries, with benefit; but the general scheme is, I believe, founded upon sound principles.

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MAY 24, 1894.

Commander C. M. CHESTER, U. S. N., Vice-President of the U. S. Naval Institute, in the Chair.

THE MANUFACTURE OF HEAVY ORDNANCE AND ARMOR; THEIR BALLISTICS AND RESISTANCE.*

By W. H. JAQUES, Ordnance Engineer.

Mr. Chairman, Members, and Guests:—With the exception of taking a small part in the indecisive debates of the Naval Graduates' Association, it has been a great many years since I lifted up my voice in this building; and then it was from yonder gallery where, when a midshipman, as a member of the choir, I joined in the weekly religious services so intimately connected with our future salvation.

To-night I shall sing the praises of the products of mechanical ingenuity which, though seemingly irrelevant for comparison, are equally important for the insurance and protection of our country.

As it will be rather difficult for me to give you within the period usually accorded lecturers the developments that have taken place in guns, gunpowder and armor since the 13th century, I may have to ask your indulgence and trust that I shall not weary you.

After 20 years of indifference to the question of national military defense, the Report of the Gun Foundry Board marked an era of awakened interest, and revived desire to see the United States again take her proper place in the maritime world.

* Illustrated by lantern views and specimens of material.

The tremendous strides we have made since that date (February 16, 1884) in the development of war materials have already placed us in the front rank in quality and type (although in quantity we are wanting) and given, in the United States, the production of this class of material a prominence in engineering science which has never before been accorded it.

A glance at the indexes of our societies' transactions will discover such a conspicuous absence of papers referring directly to the manufacture of war material that it would seem to indicate a want of interest in this branch. But, if since May, 1885, when I laid a detailed proposition before the directory of the Bethlehem Iron Company for the erection and equipment of extensive works for the production of war material and transferred to that company the initial machinery and information I had secured for the rapid and successful consummation of my project, the United States Government alone has appropriated $50,000,000 to secure for our ships and fortifications guns, armor and materials of construction, equal, and in some cases superior, to any of their kind made elsewhere; if Great Britain expends $70,000,000 annually for the care and development of her Army and Navy; if France has spent in 20 years $200,000,000 more for her Navy than the three central powers of Europe combined: I need present no further estimates of military expenditure to impress you with the value and present importance of the special branch of Ordnance Engineering. These and many other reasons suggested the thought that you would be interested by a graphic description of the manufacture of some of the heaviest implements of offensive and defensive warfare that annually absorb such vast sums of money and give honorable employment and education to so many thousands of men.

[After citing and illustrating some of the principal engineering accomplishments of the World's Columbian Exposition, and describing the types of ships that made up the Columbian Naval Review, Mr. Jaques explained in detail the construction of, and differences between, the types of modern guns known as "built-up" and "wire-wrapped;" showed what has recently been accomplished in the powders which have increased velocities to nearly 5000 f. s.; dwelt upon the advantages of the fluid compression and hydraulic forging of steel in large masses; compared the progress of ocean ship-building and the development of heavy ordnance during the

last 50 years; paid a high tribute to Krupp's accomplishment and his remarkable exposition of war material at Chicago; explained shrinkage, the erosion of the bores of guns, gas checking, and the different methods of breech mechanism; the value of alloy in steel for gun and armor making; compared hard and soft armor and showed how they should be attacked to get the greatest efficiency from the modern guns; showed the value of velocity screens placed in the rear of armor to arrive simply at the comparative excellence of armor and projectiles; and closed with a comparison of the two systems of gun construction, built-up and wire-wrapped.

The lecture was illustrated by 250 excellent lantern views, and, although concise, was a thorough exposition of the subject.]

The decrease of the number of parts in guns was a natural sequence of the development of the means in the United States for a certain production of these integers.

Birnie says of the built-up forged steel gun, it is noticeable in its history "that the length of the cylinders surrounding the tube have been steadily increased from the first conception; and its legitimate finality is a gun made, if not of one simple cylinder in each layer, at least so nearly so as to meet the requirements for longitudinal stiffness and minimize the cost of production in pace with increased length of bore."

Mr. Gledhill (of Whitworth's) has not only advocated the single cylinder in each layer, but has successfully constructed and fired guns thus made.

No great change in the composition of steel for guns has been accepted, although alloys containing manganese, chrome, tungsten, copper, nickel, aluminium, etc., have been tried with the view of securing increased hardness to resist the erosion, or a greater elastic strength to control the pressures that have accompanied the higher velocities.

In connection with the new powders, Captain Sir Andrew Noble, C. B., F. R. S., etc., in conjunction with Sir Frederick Abel, F. R. S., etc., has carried out exhaustive experiments to determine the stability and comparative values of these compounds of nitroglycerin and gun-cotton and the modern brown powders.

In his latest experiments with 6-inch B. L. Rifles of various lengths he has secured enormous energies with 0.4 inch cordite, and found great regularity of burning, stability and freedom from

detonation. He says, although its erosive power was slightly greater than that of "brown prismatic", the surface appeared to be pretty smoothly swept away, while the length of the surface eroded was much less. With very long gun, light projectile and high pressure, a velocity of 4980 ft. sec. was obtained.

It seems, therefore, that cordite is the most promising of these so-called smokeless powders, although a product of the United States called the Leonard is now giving gratifying results.

My present conclusions are that the powder question is still a trying one. With the cordite class better ballistics are obtained, and much faith is now placed in its stability, but the destruction it causes to the chamber and commencement of the rifling almost suggests a return to smooth bores.

Unless its temperature can be reduced it may have to be replaced by some other explosive.

In our Leonard powder this factor is said to obtain, but it is a comparative youth in powders, and must yet be subjected to much practical questioning. The early results obtained with it are surely most favorable.

The legal contest in Great Britain over the similarity of ballistite and cordite and priority of invention as a propulsive explosive from nitro-glycerin has resulted in the judicial verdict that there was a substantial difference in kind between ballistite and cordite, and that cordite was a novel invention. The evidence and verdict indicated that cordite had greater propulsive power and more stability and permanence than ballistite.

This wearing of the barrel to which I have referred is at the present time a cause of the greatest anxiety to ordnance engineers and gun makers. Its disastrous effects in ordnance where such enormous powder charges are employed have no doubt greatly influenced some artillerists against the largest calibres, whose racking and smashing powers must be employed to destroy the heaviest armor.

If we do not change the propelling agent I believe we must look to the amount of work put upon the metal and its treatment rather than to the chemistry alone of the metal for the determining agents that will prevent or reduce the amount of erosion; and that the solution of the problem will be found in the mechanical field. This difficulty will probably be best surmounted by carbonizing the

bore, which should be highly polished or hardened by mechanical mandreling, in order to secure the smoothness needed to prevent scoring by powder products. The employment, therefore, of any alloy or of any mechanical work that will aid in securing this highly hardened smoothness, without reducing the requisite elastic strength, will greatly assist the solution of this difficult problem. These results cannot be obtained, however, by any sacrifice of attention to the chemistry of gun steel.

If erosion is mainly due to the chemical action of the powder gases and deposits that some powders leave, the powder maker, by changing the mechanical or chemical composition of his products or substituting some other propelling agent, may pass the mechanic in his search for the means of rendering his gun barrel impervious to the destructive action of powder, just as the manufacturers of slow-burning powder outstripped the designers of accelerating guns in securing high velocities.

If we accept the new powders we may have to sacrifice the excellent ballistic results that the erosive ones have given, but if the mechanic succeeds, any kind of powder can probably be used.

If erosion is due to high pressures and temperatures the use of the stronger powders would increase erosion in the proposed short guns; but if it is due to the mechanical work of the non-gaseous (liquid and solid) residue, these new powders, if they can be made reliable, will be a boon.

By cold-rolling the tubes higher elastic strength and greater resistance of erosion will be obtained, and if the life of a gun is limited by its erosion (which is apparently the case) the increased cost to provide the power requisite for this additional mechanical work will be more than compensated by the longer life of the gun. If the addition of an alloy will facilitate this work, so much the better.

The nickel-steel gun forgings made while I was at Bethlehem show an increase of 25 per cent. in elastic strength with but a slight reduction of the contraction of area as compared with plain steel. If we can still further increase these qualities by cold rolling, we will have material that will not only stand the increased pressures demanded but will stand the erosive inroads which so manifestly control the life of our heavy ordnance.

Many examples might be given to show the advance made in

the ballistics of heavy ordnance in less than half a century, but the following résumé will suffice to show the progress that has been made. Since 1856, the powder charges have increased from 16 to 1000 lbs.; weights of projectiles from 68 to 2613 lbs.; velocities from 1600 to 4980 ft. sec.; while the energies have mounted from 1100 to considerably more than 62,000 ft. tons.

Of the two systems of breech-loading in general use, the American-French interrupted screw and what is now familiarly known as the Krupp wedge, the former is used by both the Army and Navy.

Although there have been many modifications of the original designs, the numerous broad claims of the Canet-Whitworth patents seem to cover them all. As far as simple mechanics are concerned, Messrs. Canet and Gledhill (Whitworth) are masters.

The de Bange gas check is universally used in the United States, and its pre-eminence as an effective obturator has been proved by long series of the most exacting tests.

While the Whitworth plant was only indirectly represented at the World's Columbian Exposition by the products of the fluid compression and hydraulic forging presses which I purchased of that firm, and transferred to Bethlehem, Krupp installed in a separate pavilion one of the most unique and interesting collections of preparatory and finished war material ever exhibited. It would be impossible to praise too highly the enterprise with which the risks of transportation and difficulties of installation of this remarkable collection of products were met, the masterly conception and accomplishment, and the liberality with which it was effected. It was a veritable exposition in itself.

In wire gun construction, a large amount of experimentation has been carried on, but until recently few practical results have been obtained. Wire has been so extensively used in other engineering work, that it is remarkable its employment for guns and shafting has been so long delayed.

In bridges its graceful value is especially emphasized, and I see no reason why wire guns and wire shafting should not attain the same eminence in their respective branches as the Brooklyn bridge has in bridge construction.

Placing the supply of naval ordnance in the hands of the British Admiralty has greatly improved their naval armaments; but in all navies a mistake is made in not replacing obsolete with mod-

ern ordnance of higher ballistics, even in those ships which are considered obsolete themselves. If they are useful enough to be retained in service, they would be more efficient if they had modern batteries. While the general tendency is not to exceed 67-ton guns of 13-inch caliber, case hardened armor will require larger calibers and greater energies. This has led to a revival, particularly in England and Russia, of wire wrapped ordnance, and in the former country alone, large numbers of this type, of calibers varying from 6 to 12 inches, are being manufactured. While the guest of Dr. Anderson, Director-General of Ordnance Factories, in December last, he spoke to me with great satisfaction of the results that have been obtained and the progress made in this direction. I was glad to learn from Mr. Longridge that the British Government had at last recognized his work by giving him a pension. He was naturally gratified that guns of a type so long cherished by him should now be manufactured as service guns. Since my return I have received a letter from him saying that the 12-inch wire-gun had behaved perfectly under trial, and that a muzzle velocity of over 2500 ft. sec. had been obtained, or an energy of 30,000 ft. tons.

Elswick's present position on the "wire question" has been presented through Lloyd and Hadcock in their 1893 publication on "Artillery." It states that "between the years 1875 and 1879, Elswick successfully built over 40 wire guns, the largest being of 10-inch caliber," and that "Elswick did not pursue the wire construction between 1879 and 1892 because, guns built in the usual manner having ample strength, there appeared to be no reason to accept disadvantages and especially higher cost, for the sake of obtaining what really was not necessary. The introduction of cordite and the higher pressures consequent thereupon has, however, put a somewhat new complexion on the matter, and wire will probably, to a limited extent, find its place in gun-construction of the future."

While in conclusion this extensive book of 463 pages (apparently written solely in the interest of Elswick's methods and products) states:—"Greater circumferential strength can be obtained at the expense of weakness longitudinally, higher cost, delay in construction, and slightly greater vulnerability of attack," it devotes nearly a page to the advantages of the system.

The Departments of the United States have not prosecuted this branch of gun-construction with much activity.

The Woodbridge, Crozier and Brown types constitute our principal experimentation in wire wrapped ordnance. Other systems and types have been suggested, but difficulties of various kinds have prevented their completion. A comparison of the methods of construction of the three guns here presented, the Brown, Crozier, and Woodbridge discovers that the Brown utilizes to the greatest extent the high elastic properties obtained in the segments and wire.

Birnie's criticism is that it is an uneconomical construction, because in making a gun of so many parts, it has been necessary to use metal of far higher physical qualities than would be required to secure the same tangential resistance in a less complicated way.

Dr. Woodbridge's present adaptation consists of a continuous steel tube, overlaid throughout its rear half with a cylinder of closely fitted steel staves, the whole wound with wire of either square or flat cross-section, tinned or coated with a metal of low fusibility capable of being used as a solder. The whole length of the gun is divided into three sections by steel rings or bands, and forward of the staves the wire is wound directly upon the steel tube. The splices are made by a lapping joint, brazed with silver solder, the wire being cut in a milling machine with special cutters, producing an interlocking serration of the joined surfaces. The strength of the joint was carried above the highest tension of winding by subsequent swagging in a press.

There are two features in the construction which Dr. Woodbridge considers important: To so machine and shape the longitudinal staves as to obtain a condition that will allow the employment of the whole contractile effort of the wire in opposition to the interior pressure, instead of having the resistance of the staves taking a share in it; and to winding wire with a curvature in order to reduce its tendency to unwind if cut. The accomplishment of the former would be accompanied by many mechanical difficulties, while the latter would scarcely seem to meet all the conditions of protection needed against the attack of heavy rapid-fire guns. Dr. Woodbridge states, however, that in practice the former was easily accomplished, and that he has much faith in the efficiency of the latter.

The Crozier gun, called the Ordnance wire-wound gun, being made from designs of the Ordnance Department, consists of a steel tube overlaid from breech to muzzle with steel wire wound in layers, with a jacket enveloping the wire over the reinforce, and a continuous layer of steel hoops covering the wire from the trunnion band forward to the muzzle. The coils of wire are electrically welded end to end, so that the gun is wound with a continuous strand of wire. The breech-mechanism is of the usual service type. Captain Crozier advocates the use of castings for the jackets, but in this particular gun the jacket is a forging. The general idea of the type is to have the wire as little interrupted as possible by hoops, etc., between breech and muzzle; to have the jacket take the longitudinal strain; and to so arrange the general construction that no part except the tube need be of expensive material, without any sacrifice of strength thereby.

As described by the company's engineer, "The Brown Wire Gun consists essentially of a segmental core wound with wire under such tension that the compression between the longitudinal segments of the core induced thereby will be more than sufficient to resist all ordinary powder pressure. The longitudinal segments are primarily held together by a breech and muzzle nut screwed on hot, with the proper degree of shrinkage, so that the tension of the nut and adjoining wire will be the same after winding. The wire is wound between the nuts under a high degree of tension, and anchored by a special device.

The trunnions are not attached to the core or body of the gun, but to an outer trunnion jacket, which jacket is attached to the gun proper by means of the breech nut. By this means the recoil is transmitted to the trunnions through the breech nut and jacket, and the core or body of the gun is thus relieved from the major part of the longitudinal thrust due to powder pressure upon the bottom of the bore. The gun itself is free to expand longitudinally within this jacket, which is attached only to the breech nut. The essential feature of the gun is, of course, the segmental core. This core consists of a number of longitudinal steel segments, the number being so regulated that the maximum thickness of a segment shall not exceed one-half inch materially. The chase jacket consists of a series of interlocking hoops shrunk on over the wire, extending from just in advance of the trunnions to the muzzle,

the entire jacket being held in place by a muzzle nut, the thickness of which and the amount of shrinkage being so adjusted that when completed the compression produced by the building-up muzzle nut will be the same as that produced by the wire and chase rings."

During the progress of the work, which has been extended over a period of three years, mechanical difficulties and the results of the trials of experimental cylinders representing sections of the powder chamber gave reason for decreasing the number and increasing the size of the longitudinal segments and the necessity for the insertion of a lining tube to prevent the entrance of the powder gas between the segments, which, in the case of one of the experimental cylinders, was so great as to cause marked discoloration at the joints. The lining tube was inserted under initial tension and extended to about five or six calibers in advance of the front end of the chamber. This tube can be removed and replaced by a new one whenever it becomes too much eroded for service.

Mr. Brown claims that the fundamental principle of his gun lies in the segmental tube and not in the wire wrapping. He has never asserted that he was the inventor of the wire gun, nor that the use of the segmental tube was new; but he believes that the idea of sub-dividing a core for the purpose of obtaining special elasticity is original with himself, and that thereby it is possible to set up such a high degree of initial compression that even under the highest powder pressure the compression at the surface of the bore will not be reduced to zero.

If the segments compressed by the full elastic strength of the wire present an interior surface that can withstand the erosive action of the powder products, we must admit that Mr. Brown has supplied a method of forming the bore of the gun which has decided advantages; but if recourse has to be had to a liner to resist erosion we return to a core that will not sustain the full elastic strength of the wire, and it probably will be more economical to use a steel tube of suitable dimensions than a combination of segments and thin liners, unless these liners like the segments, are cold drawn, and thus by a great amount of mechanical work rendered impervious to the serious ravages of the powder products.

Although the Woodbridge and Brown guns have developed defects, the 162d shot of the latter (5-inch Brown) with 30 lbs. of

Leonard smokeless powder, gave a muzzle velocity of 3240 ft. sec. to a 63 lb. projectile, and stood a pressure of 65,300 lbs. per square inch. The Crozier has not yet been tried.

The wire-wrapped type, a 9.2-inch B. L. rifle had the honor of firing the "Jubilee Round" at Shoeburyness, April 16, 1888. This 22-ton gun fired a 380 lb. projectile with 270 lbs. of powder, at a muzzle velocity of 2360 ft. sec., the range being 12.4 miles, and the height of trajectory 17,000 ft. when fired at 45 degrees elevation.

Comparing the velocity, however, with a more recent 6-inch quick-firing gun (hooped), a velocity of no less than 4928 feet has been realized with a 19½ pound charge of cordite.

As to the comparative value of the two systems, there is now such abundant evidence in favor of each, that the choice may be governed, like a lady's toilet, by a caprice of authority.

Between the best examples of the two types, there appears to be so little difference that a mistake could hardly be made by the selection of either.

Birnie's conclusions are "that on the whole there is little to be gained in attempting to make wire guns to be professedly stronger tangentially than the forged guns. And if equal strength only is aimed at, then the forged gun has the advantage of being inherently the more solid and stiffer construction."

In relation to armor, the United States is not the only nation successfully producing hard armor, nor is the method employed by Mr. Harvey the only one the gun has to meet. Hadfield's manganese plates, the Schneider gas-hardened type, St. Chamond's nickel-chrome products, and Krupp's special type have all scored "touch-downs," and others are in training.

The views which I shall show you* will give you a much better idea of the behavior of the plates than any detailed description I could give you. The failure of some of the thicker case-hardened plates has caused much doubt as to the thickness which will be improved by the so-called "Harvey" process. 13-inch, 12-inch, and even 10-inch armor-piercing shells, attacking at service energies, have cracked them; and although increasing the number of bolts may

*Mr. Jaques illustrated his description with 85 specially selected views representing all the principal plates tested since the Spezia trials of 1886.

keep the cracked pieces in position, we find ourselves back again to the old discussion as to which is least objectionable, considerable penetration or cracks. No matter what future tests may decide, one thing is certain, the calibers and energies of guns must be increased, not diminished.

The complicated shapes and varying sections of armor demanded by the naval architect add seriously to the risk of manufacture and treatment of steel plates. They are now required to be shaped as if they were mahogany, and naval architects have not reached their ambition of complexity, although one might suppose the ram Katahdin was rich enough in graceful curves.

The value of velocity screens behind plates in testing armor and projectiles demands a moment's notice. The suggestion to employ velocity screens behind plates in testing armor has, I believe, been more specifically recommended by Captain Orde Browne and myself than by others.

Very little has been done in this direction, although much valuable data could be obtained by their use to replace assumed arbitrary conditions, and to lessen the demand upon the Greek alphabet, which is so copiously drawn upon to represent the unknown quantities of ballistic equations. Not only is this true in determining the comparative resistance of plates, but equally so in grading projectiles, which in many cases fired with high velocities are either lost or not discovered until one of the approximate elements of value—*heat*—has disappeared.

In closing, I cannot refrain from saying a few words in relation to the arguments which are so frequently set forth by representatives who cannot see beyond the environs of their own cities or states and are, therefore, too narrow to understand the value even to themselves, of an adequate coast defense. They protest that such preparation is uncivilized; that no country will ever attack us; that we have no dangers to fear from the outside world; they want us to submit everything to arbitration.

All history, however, recalls the dangers of vast acquisitions of wealth without adequate protection. The United States is rapidly overreaching other nations in the vastness and variety of what is supposed to constitute wealth. Labor has been as favored as capital.

An insurance of some sort is absolutely necessary upon this nation's wealth and the people who have been induced by our wise laws to acquire it. Why then should we hesitate to apply almost any amount of money for the development of our various lines of defenses, when the amount ($126,377,800) recommended by the most ambitious board ever appointed—the board on fortifications or other defenses—would require a tax rate of less than one-fourth of what we pay for the insurance of our property against fire?

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

ORDERS AND SIGNALS OF THE VENETIAN FLEET, COMMANDED BY MR. JAMES DOLFIN, A. D. 1365.

By REAR-ADMIRAL LUIGI FINCATI, of the Italian Navy.

(Translated by Medical Director Philip Lansdale, U. S. N., and kindly contributed by Rear-Admiral S. B. Luce, U. S. N., President of the U. S. Naval Institute).

INTRODUCTORY.

When treating of the subject of signals, some years ago, for "Johnson's Universal Cyclopædia," there was left over material enough for a magazine article, which, in due time was published. In the endeavor to trace, in this article, back to its source, the history of signaling at sea, some interesting facts, in connection therewith, were brought to light. One especially so, was the method given by the Emperor Leo V., which bears a striking resemblance to the system known with us as the Army Code or "Wig-Wag."

Impressed with the belief that there must be stores of valuable information relating to the naval affairs of mediæval times, hidden away among the public or private archives of Italy, a copy of the magazine was sent to a friend in the Italian Navy. Accompanying the article was a note suggesting that a search among the libraries of Venice and Genoa might possibly lead to the discovery of the system of naval tactics practiced by the fleets of those once great centers of naval power. Failing in this, it was thought that if the code of signals then in vogue could be found it would furnish a clue to the tactical formations of the period. The letter and article were referred by my friend to Rear-Admiral Fincati, who had given much attention to naval archæology. The result was the two articles on Signaling and Naval Tactics* which follow.

*The article on Naval Tactics will appear in the next number of the PROCEEDINGS.

Though written fifteen years ago, these articles have lost none of their value. On the contrary, with the dissipation of the false idea that modern naval science had nothing to learn from the past, there has been a decided tendency of late years towards what may be called the philosophical study of naval history. This enables the student to generalize on certain leading facts, and to deduce therefrom the general principles which underlie all naval operations of whatever times or countries. In this view of the case the articles are really quite as opportune now, in this country, as when first written.

That they have not appeared before is due, first, to the difficulty of getting them translated; and secondly to the pressure of other work which has until now interfered with their preparation for publication.

The translation, which pretends to be little more than a literal rendering of the Italian into English, was finally undertaken by Medical Director Lansdale, a work for which he was well equipped. To a wide experience in naval matters he added a rich fund of classical knowledge, and his work, which was literally a labor of love, was performed with characteristic conscientiousness and fidelity.

Advantage is taken of this occasion to express my regrets for this unconscionable delay; and at the same time to tender our acknowledgements to the learned author for his valuable and interesting contributions to our professional literature.

S. B. LUCE.

In an article on "Signals and Signaling," a distinguished officer of the American Navy, Post-Captain S. B. Luce, gives an interesting account of day and night signals afloat and ashore, commencing with the earliest times. He goes back to the time of Moses in the Wilderness, and to the beacon fires, to the splendor of which Homer compares that of the arms of the divine Achilles. The author describes the signals of the Greeks, and of the Trojans, those cited by Æneus Tacticus, a contemporary of Aristotle and of Polibius, and so on downward. After having noticed also the secret communications with the Scitalus of the ancients, he comes to the signals prescribed by the Emperor Leo the Wise for his fleet, by means of the "Canularkion" and of the "Phenekida."

From the signals of the Byzantine fleet, he passes on to describe the first attempts made by the English fleet, whose signals in the time of Richard I., during his crusade against the Saracens, consisted in sounds of the trumpet, which issued from the admiral's ship. During 146 years of signaling in the fleet, the English seem

to have made no progress; but it appears from the Black Book of the Admiralty, written about 1351, in the Franco-Norman language, that at that period they commenced to make use of some visible signals.

From the time of Edward III., the author passes on to run over those of the time of Henry V. (1415), of Elizabeth, and the Duke of York (Grand Admiral of England), to come down to modern times, with the famous signal, "England expects every man to do his duty," hoisted by Nelson, on the Victory (1805), and to that of Perry, hoisted on the Lawrence (1813), "Don't give up the ship,"—the dying words of the valiant Captain Lawrence, who gave his name to the ship, and the future war cry of the American Navy.

The able writer desired to include the system of signals used by the Venetian fleet, as he well saw that the omission of this would leave a blank in his work. For this purpose and through the medium of Cav. Martinez, post-captain in our Navy, and a mutual friend, he did me the honor of applying to me for the necessary information. I promised to investigate the very rich archives of Venice, and to communicate to him the fruits of my researches, but my protracted absence from that city rendered it impossible for me to comply with my promises, and meanwhile his work was published in a monthly illustrated magazine of Philadelphia. But now, thanks to the courtesy of my friend Comr. Cecchetti, superintendent of the Archives of State, I have obtained knowledge of a very curious document of the 14th century, which contains precisely the signals used on board the Venetian fleet at that epoch, and without doubt at more remote periods also.

This is one of the usual edicts, entitled "Orders and Commands," which every commander-in-chief of a naval force published on taking command of his fleet, in which is indicated, more or less definitely, the method the captain intended to pursue in the various contingencies of navigation and combat, the rules of discipline, and the penalties prescribed for offenders.

One patient collector, Sr. A. Jal, has published the "Orders and Commands of the Magnifico Mr. Piero Mocenigo, Captain-General of the Sea,"* but these are much more recent than those of Mr.

* "The publication of the Orders and Commands of Mocenigo, made by Sr. Jal in the original Venetian dialect, abounds in typographical errors, to which

Giacomo Dolfin, which form the subject of my present study, and which, because of their greater antiquity, awaken a greater interest.

For this reason, and because of the incorrectness of the publication of Sr. A. Jal, and to comply, even though tardily, with the wishes of the American commander, I have determined to publish the Orders of Mr. Dolfin, a most important page, be it remarked, of the Naval History of Italy.

It will be seen with how few, and very simple signals, sustained by intelligent preliminary arrangements, all the necessities of navigation and battle could be provided for.

It is true that communications could not be made at long distances, as at the present time; but herein were avoided many causes of confusion and error as well as the possibility of inopportune announcements and demands; and we may readily agree with the wise Emperor Leo, who, after having described a great number of signals, said to his captains: "But, after all, to avoid confusion and error thou hadst better make signal with the hands in the old-fashioned way."

For the benefit of the philologist it may be stated that the text, in its ingenuous grammar and extravagant orthography, is not very difficult for educated Italians; but for the more ready use of foreigners, who, more than ourselves, seem interested in the study of our ancient documents, I have rendered it in a more modern reading.

This document, precious in many aspects, is found in the Archivis Notarile of Venice among the "Acts" Boninsigna Giovanni I., 4, whence it was transcribed by the distinguished Sr. Baracchi, the coadjutor, and with the assent of the Hon. Sr. G. Perrin, director of that office. To these gentlemen I beg to offer my thanks.

are added those of translation, even to the point of confounding a simple sub-officer (the pilot, helmsman, or quartermaster (?)), with the general officer commanding in chief a fleet, and the captain-general *of the sea* with a fantastic functionary no longer existing." . . . This paragraph, and the preceding, informs us that in Venice, in the 14th and beginning of the 15th century, the admiral was the general officer commanding the squadron, and that the captain-general of the sea was the administrative and military chief of all the maritime forces of the republic,—minister and general at the same time. (!!!)

NOTE.—Jal's *Archeologie Navale*, Vol. II., p. 137, is here referred to.—S. B. L.

How and when writings of this kind, with notarial protocols, and others on other subjects, found their way into the archives it is useless here to inquire. But, believing that very numerous political and private documents, containing very copious information of the civil life, customs, language and institutions of our country are to be found there also, I can but deplore that so many historical treasures should be so amassed, without a service coördinate to the work, and with a personnel insufficient to adminster it,—deprived of adequate means and poorly compensated.

Among more urgent questions, these poor things of the Archives breathe out their aspirations and laments in vain; but it may be hoped that the time is not far distant when the progress of instruction may move the indifferent, and some one may be provided to carefully preserve and set in good order, for presentation to the student, a valuable historical store that will include this collection in the Archives of State,—which will then appear complete and reunited.

The illustrious Cecchetti, to whose friendship I owe the communication of this document, has requested that I should enrich it with suitable illustrations. But, considering that the obscurity of the text proceeds not so much from its nautical character as from the Venetian dialect in which it is expressed, I believe that, in having made a kind of translation, I have caused all obscurity to disappear.

SEPT. 9, 1365.

In the name of God, of the Virgin Mary, and of Mr. St. Mark, the Evangelist, our Chief, and of all the Saints:

ORDERS,

given in the noble name of Mr. James Dolfin, captain of the four galleys of the Station of Cyprus.

Firstly.—The captain orders and commands that no person shall dare to offer any injury to our Lord God,* His most Holy Mother,

*It is interesting to note here that the example of a formal recognition of the Supreme Being in the very first article of the Code of Discipline of the Venetian fleet was followed in the Articles of War enacted by Parliament in the

or to any Saint, male or female, either by word or deed, under whatever penalty the captain shall think the offense may merit: noting, that the punishment should not be too severe.

It is ordered, moreover, that the galleys being assembled, that of Mr. Nicholas Bembo must keep on the right side of that of the captain; that of Mr. Bernard Balbi on the left side; and that of Mr. Francis Corner on the left of the preceding. The same position will be maintained when under sail, as customary; under penalty of one hundred soldi.* (80 cents.)

Item.—That none of the galleys shall pass beyond the *focone* (kitchen, galley, cuddy, cook-house) of the captain under penalty of 20 soldi (16 cents) for every offense.

Item.—That no galley shall pass the prow of another under the same penalty.

Item.—If the captain should wish to race (*i. e.*, try rate of sailing), he will place his cornet upon the prow. All the galleys will then do the same, struggling to excel in speed, without doing injury to one another.

Item.—Whenever the captain shall desire the fleet to draw up in line of battle, abreast, he shall cause his cornet to be placed upon the beacon, inclined towards the head of the "standard"; that is, towards the prow.

And when he wishes to form line ahead (in file, one behind another) he will cause the cornet to be raised, and this shall be observed under penalty of 40 soldi (32 cents) for each time that it shall be transgressed.

Item.—That no galley shall spread awnings unless the captain shall have done the same; nor furl them unless the captain shall have furled his; and this shall be observed under penalty of 20 soldi for each transgression.

Item.—That no galley shall lower a boat nor get out a ladder before the captain does, and this under penalty of 100 soldi for each and every offense.

reign of Charles II., which articles were adopted bodily, with a few verbal changes, as the law for the better government of the U. S. Navy.

The practice is inculcated of holding Divine service during which irreverent conduct is reprehended.—S. B. L.

* Old currency. 100 soldi at present would represent 95 cents American money.

UNDER SAIL, BY DAY.

Item.—When the captain wishes to make sail, all the galleys will cease rowing and abstain from going ahead, keeping apart so as not to fall foul, and remaining at their posts under the wind of the captain, and this under penalty of 100 soldi.

Item.—That no one shall take the wind of another under penalty of 100 soldi.

Item.—When, under sail by day, the captain wishes to have council or come to a vote, he will place a large flag on his boat; then all the galleys shall approach skilfully that of the captain, and every one shall advise as he sees fit. If at night the captain should wish to review the galleys, he will set a light upon his beacon, keeping it steady; every galley will then place and will keep a light on the poop, during all the time that the captain shall preserve his in that position.

AT NIGHT AT SEA.

Item.—If the captain wishes to make sail at night with the mizzen, he will show two lights amidships, one by the side of the other.

If he wishes to set the foresail, he will show 3 lights amidships, one by the side of the other.

If he wishes to set the *papafiga*, he will show in the same manner 4 lights.

If he wishes to set the *cochina*, 5 lights similarly arranged.

Item.—If the wind should increase so that the captain should wish to furl any of said sails, he will show six lights, one beside the other "at half galley" (amidships), and each one should reply with the same signal.

Item.—If the captain desire to take in either of said sails, he will show two lights, one below the other, "at half galley."

And if he wish to run without sails, after having shown the above signal to take in sail, he will place a light below the beacon; and keep it there as long as he wishes to run without sail. Every galley shall keep at the same time a light upon the poop, and shall extinguish it when the captain removes his own; and this shall be observed under pain ot 100 soldi.

Item.—If any disaster should happen to a galley at night (which

may God avert!), she will show as many lights as she can; all the other galleys shall hasten to assist her. And if it happen by day, she shall hoist her ensign (*insigna*), on which all will go to her assistance.

Item.—Let no galley "rub against" (collide laterally with) another, under penalty of 100 soldi. And if from such collision any damage result, she shall restore it. The transgression shall be punished at the pleasure of the captain.

Item.—If any one fail in his watch, he shall be mulcted in 3 grossi,* for each time that he fails.

Item—Let none of the men of the galleys, nor any soldier dare to bear arms on shore, either in subject territory or elsewhere, under pain of forfeiting the arms, which will be the pilot's, and a fine of 15 lire ($2.40) for every sword, and 3 lire (48 cents) for every knife.

Note that the arms must in this case be the individual's.

Item.—No one shall sell wine until it shall have been tested, and after having been tested, he may not add water to it; under penalty of losing the *barrel*, which will then go to the informer; and the wine may be given to the crew to drink.

OF GAMING.

Item.—The captain desires that there be no paying up of money or other things bet; nor to any one who lends for betting; but that, instead, he be constrained to give back the pledges that he may have received to this end.

Similarly, every one will be constrained to restore the clothes and garments won or obtained by gaming, to those who may have lost them; and these can make the demand with security and without fear of punishment.

NAVIGATING UNDER OARS IN DAYTIME.

Item.—If by reason of storm or any other cause, the galleys have lost sight of each other, or become separated, and then heave in sight again, under oars, those who find themselves in the greater number shall send ahead one of their number, which one will place herself across, hoisting her flag aft and another forward.

* *Grisso*, a Tuscan penny.

Those who find themselves in the lesser number will hoist two flags amidships, one to the right and the other to the left, and then come within hail, poop to poop, so that they may recognize each other. And should they be in equal number in both parts, they will recognize each other with the same signals.

Item.—If, instead, they make each other out under sail and in daytime, each one will hoist a flag over the top, and then put two flags forward, hauling down the one on the top. And by these signs they will recognize each other to be friends.

Item.—If all this occur at night, the first who wishes to signal will show three lights amidships, one over the other, and the others will show four disposed in the same way.

After this, those who have three will carry one to the poop, one to the bow, and will preserve the third amidships; those who have four will then carry two forward and two aft.

And thus they will know themselves to be friends.

But should they judge themselves to be in a suspicious locality, they are not required to show any lights whatever.

AGAINST THE ENEMY.

When the captain wishes to chase a galley, or armed vessel, he will set at the prow of his galley the ensign with his arms.*

All the galleys shall then stand towards the galley or galleys, or ship, it is desired to chase, with all the speed they can command, without contravening the preceding orders; and every one that may be overtaken and captured, shall be taken possession of with the least possible damage, until the captain shall arrive upon the spot, provided this can be done without injury to the one that has made the capture.

Item.—When the captain desires the galleys to cease chasing, he will haul down his own flag; every galley will then cease chasing and return to her post. This shall be observed under such penalty, pecuniary and personal, as may seem good to the captain.

Item.—If it should happen that the captain desires to go into action, he will hoist the flag with his arms on the right side of

*Each Venetian galley, besides the standard of St. Mark, carried a flag bearing the arms of the commander.

the poop; each galley will then take her assigned position, and at the first sound of the trumpet, each will get ready the proper arms. At the second call, every one must be armed and ready. At the third, every one is to follow the captain and fight vigorously, or stand firm and ready to receive the enemy, as may be ordered; or maintain the conflict and fight vigorously until the battle is ended, and this shall be observed under forfeiture of the head of whoever may infringe it.

Item.—Let no one dare to throw himself into the water during the fight, nor to plunder under penalty of death.

Item.—If by chasing or by fighting, any galley or vessel whatever should be captured, no person shall dare to plunder anything whatever, under such penalty as may seem good to the captain, either pecuniary or personal, and no one shall retain what he has stolen. Similarly, every person is forbidden to offend any person captured.

Item.—The captain wills and commands that all the aforesaid orders shall be well observed, under the penalties indicated, more or less, according to the offense committed.

Of the Orders and Commands of Mr. Piero Mocenigo alluded to above (page 543), it will be interesting to reproduce some of the orders relating to the "galleys of guard," and to the combat.

Art. 15.—The Captain orders, etc.:—

That at sunset the guardship shall go outside of the port and maintain such a position as shall enable her commander to descry any vessel, or fleet, coming towards the port, and to give notice to the captain in the following manner: If he discovers armed vessels he shall show one light, hiding it and displaying it as many times as there may be vessels observed.

If, after having made signal of an armed vessel discovered, the captain-general answers with a similar signal, he shall stand towards it, carrying a light upon the poop, that the captain may see the direction he is taking, proceeding cautiously, and in good order, and before he gets near he shall make the signal of recognition, as is prescribed. Having received a satisfactory reply, he will approach circumspectly, cross-bow (at least) in hand, to avoid surprise.

But if, by chance, the discovered vessel shall not reply, he shall let off his cross-bows, shooting from afar, and shall proceed to board her in whatever manner he thinks best. If she flies, he shall follow, not going so far, however, as to lose sight of the light of the captain nor to get out of sight himself.

If the captain shall see that the guardship does not continue the chase, he will set two lights below his beacon, one under the other; the chaser will then return to his post.

If the guardship shall discover more armed vessels, so that it may be necessary to take arms during the night, the captain will hoist 4 lights on the poop, one under the other; every galley will then put all its people under arms, and make the *impanosta* (to receive the communion(?)) so that, at the first sound of the trumpet, all shall be armed; and at the second, all shall be ready. At the third sound, all shall go into the fight, in good spirit, ardently, but no one shall dare to attack before the third blast, nor retire before the battle is finished, under pain of death.

If it should happen, which may God avert, that the enemy be so numerous that it may seem better to fly and *give the poop** (show our stern), the captain will hoist 3 lights, one below the other; all will then follow, in good heart, without fear, not abandoning each other, but defending themselves with vigor and boldness, mutually comforting and animating each other.

Whenever the fleet shall prepare to leave port, the guardship shall not abandon her post until daylight, then she will precede the fleet at sea by the space of one or two miles; and, at sunrise she should hoist a flag and send a man aloft to scan the horizon. If she discover one or more armed vessels, she will hoist the flag of St. Mark and lower and run it up as many times as there may be ships in sight. If there be more than one, pursue the system of signaling with flag, as at night with lights.

If the captain decide to go into action, he will hoist on the poop the golden standard bearing his arms. At this signal all the galleys shall draw up in line of battle about him in the post to each assigned. They will make the usual barricades forward (at the prow) of shields and bucklers. At the second signal of the trumpet, the ensign of St. Mark will be hoisted, and they will take

*The expression "give the poop" corresponds exactly with "to present, or show, the back or the heels."

refreshments for the body (by eating and drinking to invigorate the strength). When they shall see hoisted amidships the square banner of our Lord Jesus Christ, they shall hasten, every one ardently and in good order, without one galley fouling another, to assail the enemy, and shall not withdraw from the fight until the last extremity. And if, peradventure, any one shall attempt to assail before the signal, or shall attempt to withdraw from the engagement, he shall be punished as a traitor.

It is notable, the insistence with which, in all documents of this kind, is repeated the warning, that no one shall dare to withdraw from battle before the end of the combat, and reminded of the terrible penalties reserved for transgressors.

In the same manner in which the captain of the fleet impresses this prescript upon the commanders of ships, the government does not omit to devote a chapter to it in its instructions which are given to the chiefs of every maritime expedition, and then to bind their personal responsibility, citing always the law of Aug. 10, 1294, which strikes at all transgressors whatever who may have been engaged, and is applicable not only to the commander, but as well to all the officers on board, and also to the sub-officers and steersmen, not excepting any but those found "manifestly not culpable."

[Here follows an extract from the law in Latin, a translation of which is appended.]

The origin of this wise law (severe and never repealed), goes back to the times of Demosthenes, who, in his oration "de corona," says: "I marvel that, while it binds and punishes the sailor who abandons his ship, it does no less to the captain who abandons his fleet." And, perhaps it was called for by some shameful act, a repetition of which it was urgent to prevent, but which, after that epoch, was never repeated with impunity.

This particular crime, which the Greeks call "anaumakia," was by them punished with "ignominy," which, together with the criminal, punishes also his son. Xerxes, as we know from Diodorus Siculus, punished it with capital punishment, and all nations ancient and modern, however valorous, perceived and

provided for the necessity of terrible penalties against him who shrinks from the fight by sea or land, and never dispensed with the vigorous application of them without disaster to their arms and most serious misfortune to their country.

L. FINCATI, *Rear-Admiral.*

Translation of the Latin Text of the Law Cited Above.

. . . YEAR 1294, *Aug.* 10.

. . . if a ship fails to take part in the action, or having taken part, retires before the combat is finished, the commander, officers, sailors and steersmen shall lose their heads, and if any of them cannot be found, they shall be forever banished from Venice and from all territory subject to the Duke and commands of Venice.

Those only excepted who *manifestly* were not culpable, and this cannot be revoked but by five councillors, thirty of "the Forty" and two-thirds of the Great Council.

NOTE. It was under a provision similar to this, contained in the code of discipline of the English Navy, that the unfortunate Byng was condemned to death. Afer the execution of that gallant officer, the law, which up to that time admitted of no alternative but the death penalty, was changed so as to read that "any person in the naval service who in time of battle displays cowardice, negligence or disaffection, etc., etc., shall suffer death or *such other punishment as a court-martial may adjudge.*" The words in italics being added. In this form it was adopted by Congress.—S. B. L.

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THE DYGOGRAM; ITS CONSTRUCTION, DESCRIPTION AND USE.

By LIEUTENANT JOHN GIBSON, U. S. N.

The dygogram is one of the graphic methods of representing the deviations of the compass for magnetic headings; it also shows the horizontal components of the magnetic force acting on the compass needle, the directions in which they act, and the deviations produced by each component as well as the total deviation for any magnetic heading.

The word "dygogram" is a contraction for "dynamo-goniogram," meaning a "force and angle diagram." It is a geometrical construction fulfilling the conditions of the general expression

$$\tan \delta = \frac{\mathfrak{A} + \mathfrak{B} \sin z + \mathfrak{C} \cos z + \mathfrak{D} \sin 2z + \mathfrak{E} \cos 2z}{1 + \mathfrak{B} \cos z - \mathfrak{C} \sin z + \mathfrak{D} \cos 2z - \mathfrak{E} \sin 2z},$$

as will be shown further on.

To CONSTRUCT THE DYGOGRAM WHEN $\mathfrak{A}$, $\mathfrak{B}$, $\mathfrak{C}$, $\mathfrak{D}$ AND $\mathfrak{E}$ ARE KNOWN.

Navigators of the U. S. naval service have blank forms supplied upon which there is a vertical scale, OP, representing unity, which is divided into 100 equal parts, and by estimate into 1000 parts; and an arc, with O as a center and radius equal to OP, divided into degrees, upon which deviations may be read off. When no blank is at hand, a similar scale may readily be constructed. In all cases the line OP is equal to unity and is vertical, and at P there is a horizontal line.

Example.—Let $\mathfrak{A}=+.053$, $\mathfrak{B}=+.222$, $\mathfrak{C}=+.220$, $\mathfrak{D}=+.226$, $\mathfrak{E}=+.063$.

For reference, see Fig. 1.

From P lay off $PA=\mathfrak{A}$ to the right if $\mathfrak{A}$ is +, to the left if —.
" A " $AE=\mathfrak{E}$ " " " $\mathfrak{E}$ " +, " " —.
" E " $ED'=\mathfrak{D}$ upwards " $\mathfrak{D}$ " +, (as it usually is).
" D' " $D'B'=\mathfrak{B}$ " " $\mathfrak{B}$ " +, downwards if —.
" B' " $B'N=\mathfrak{C}$ to the right " $\mathfrak{C}$ " +, to the left if —.

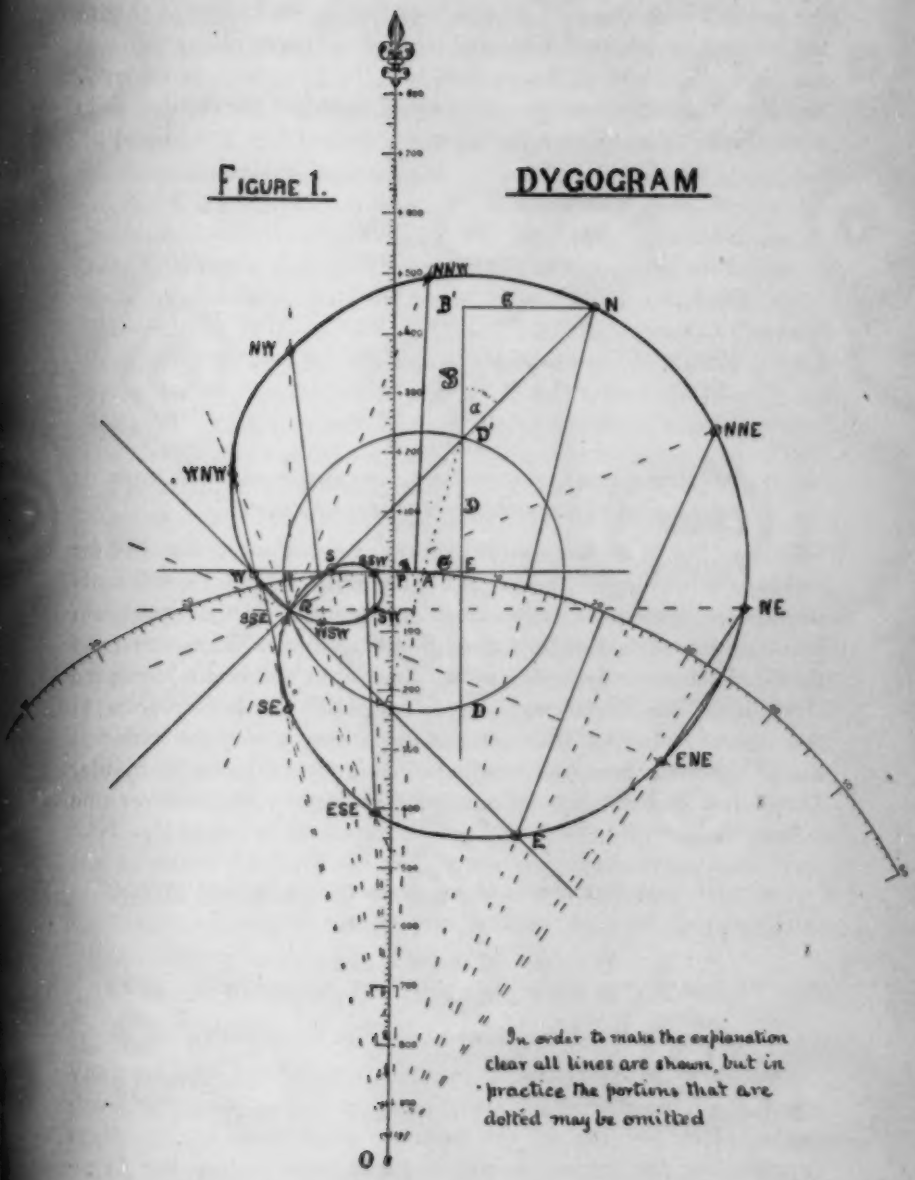
With A as a center, and a radius equal to $AD'=\sqrt{\mathfrak{D}^2+\mathfrak{E}^2}$, describe a circle, called the "generating circle." From N draw a straight line through D' and produce it until it intersects the generating circle a second time, which point mark Q. The point Q is called the "pole" of the dygogram and is one of the necessary points to have. From D' lay off towards Q a distance $D'S$ equal to $D'N$. Take a straight-edge of paper of sufficient length and lay it down on NS; mark, on the edge of the paper, dots opposite the points N, D' and S; move the paper around so that the center dot moves on the circumference of the generating circle and with the edge always passing through the pole Q; by means of pencil dots opposite the end marks on the paper-edge, a sufficient number of points may be obtained for drawing in free hand the curve of the dygogram.

To mark the dygogram for magnetic headings, lay a protractor on the line NS, its center at Q, and dot off the headings required (usually every other point); through each of these points and through Q draw a line and extend it across the dygogram. Where the lines cut the dygogram are the points required; the first cut to the right of N (looking from S. to N.) is say NNE., the 2d, NE., the 3d, ENE., the 4th, E., etc. Draw small circles around the points and mark each one correctly.

To Construct a Table of Deviations for Magnetic Headings when only the Exact Coefficients are Known.

Having proceeded so far as to find the required points of the curve and marked each correctly, as explained above, draw a line from each point to O (or until it intersects the graduated arc); the deviation then for each magnetic heading is shown by

FIGURE 1. DYGOGRAM



In order to make the explanation clear all lines are shown, but in practice the portions that are dotted may be omitted

the angle which the line drawn from that point makes at O with the vertical graduated line, and is read off from the graduated arc; if to the right of the vertical line the deviation is easterly, and if to the left, westerly. It is usual to record the deviations in a tabular form as follows (as example, case of Fig. 1 is taken):

Magnetic Heading.	Deviation.	Magnetic Heading.	Deviation.
N.,	13° 05′ E.	S.,	5° 55′ W.
NNE.,	23° 35′ "	SSW.,	1° 40′ "
NE.,	32° 10′ "	SW.,	1° 40′ "
ENE.,	34° 00′ "	WSW.,	7° 40′ "
E.,	21° 00′ "	W.,	13° 10′ "
ESE.,	2° 40′ W.	WNW.,	13° 10′ "
SE.,	12° 40′ "	NW.,	7° 20′ "
SSE.,	11° 15′ "	NNW.,	2° 15′ E.

TO CONSTRUCT A TABLE OF DEVIATIONS FOR COMPASS HEADINGS WHEN ONLY THE EXACT COEFFICIENTS ARE KNOWN.

In practice it is necessary to have a table of deviations for "compass headings," and to get it when only the exact coefficients are known, proceed as explained for constructing the dygogram and the table of deviations for magnetic headings. Then construct the Napier's curve by laying off on the Napier's diagram along the "full lines" the deviations for the magnetic headings; draw in the curve and then take off the deviations along the "dotted lines" for the "compass headings"; and record them in tabular form, one column being "Compass Headings" and the other one "Deviations."

TO SHOW THAT THE DYGOGRAM SATISFIES THE CONDITIONS OF THE GENERAL EXPRESSION,

$$\tan \delta = \frac{\mathfrak{A} + \mathfrak{B} \sin z + \mathfrak{C} \cos z + \mathfrak{D} \sin 2z + \mathfrak{E} \cos 2z}{1 + \mathfrak{B} \cos z - \mathfrak{C} \sin z + \mathfrak{D} \cos 2z - \mathfrak{E} \sin 2z}.$$

For reference, see Fig. 2.

Construct the dygogram, as previously explained, and take any point R of the dygogram corresponding to the magnetic heading z. The position of the different coefficients, or the lines representing the forces, as laid down in constructing the dygogram, are for a magnetic heading north; for any other heading z the lines and different triangles remain of the original size, but

assume new positions in regard to the center A. As the ship swings through the magnetic azimuth z, the keel line $DD'B'$ swings around D as a center, through the angle z, in the new position $DD'K$, cutting the generating circle at the point D'. According to the construction of the dygogram a line, $QD'R$, making an angle z at Q with the line NS, will cut the dygogram at the point for the azimuth z; this line will pass through D' because the angles $D'QD'$ and $D'DD'$ are each equal to z, and, as both Q and D are on the circumference of the circle, the angles are each measured by half the same arc, $D'D''$. According to the construction, $D''R = D'N = \sqrt{\mathfrak{B}^2 + \mathfrak{C}^2}$, and by geometry, the angle $B'D'N = KD''R = a$; therefore, a perpendicular let fall from R upon DD'' produced will cut at K such that $D''K = \mathfrak{B}$ and $KR = \mathfrak{C}$. Thus it is seen that, in swinging through an azimuth z, the triangle of polar forces, $D'B'N$, has assumed the position $D''KR$.

The triangle AED' will revolve around A as a center in such a manner that while the ship turns through an angle z, the triangle AED' will turn through an angle $2z$. Above it was seen that half the arc $D'D''$ measured the angle $D'QD'' = z$; therefore, the angle at the center, measured by the same arc, would be equal to $2z$; that is, $D'AD'' = 2z$, and therefore the other sides of the triangle, AE and ED', will turn through the angle $2z$; or $EAE' = 2z$ and $E'D''D''' = 2z$ (D''' being vertically below D'' on the line PBC).

The forces, as represented by the coefficients, have kept their original values or strength, but now act in new directions to produce deviation and to affect the directive force of the needle. $PA = \mathfrak{A}$ remains constant; $AE' = \mathfrak{E}$, but acts at the angle $2z$ with its former position; $E'D' = \mathfrak{D}$ acts at an angle $2z$; $D''K = \mathfrak{B}$ and $KR = \mathfrak{C}$, but each acts at the angle z with its former position.

From each of the points E', D', K and R let fall perpendiculars upon the two axes having P as an origin.

As R is the point of the dygogram for azimuth z, the deviation $\delta = POR$; then, $\tan \delta = \dfrac{LR}{OL}$, in which LR = force of earth and ship to magnetic east in terms of mean force to N as unit; OL = force of earth and ship to magnetic north in terms of mean force to N as unit.

By referring to the figure it is seen that the angles

$$NQR,\ D'DD'',\ D'QD'',\ DD'D''',\ D''KB,\ KRL$$

are all equal to each other and to the azimuth z. It may also be seen that

$$D'AD'' = EAD' - EAD''\ ;\ E'AS = E'AD'' - EAD''\ ;\ \text{or}$$
$$EAD'' = E'AD'' - E'AS\ ;\ \text{hence}\ D'AD'' = EAD' - E'AD'' + E'AS.$$

But $EAD' = E'AD''\ ;\ \therefore\ D'AD'' = E'AS = 2z = MD''D''' = ME'S.$

Now, $$LR = PC = PA + AS + SD'' + D'''B + BC;$$

but $$PA = \mathfrak{A}\ ;\ AS = \mathfrak{E}\cos 2z.$$

Let $$E'M = r \text{ and } MD'' = s\ ;\ \text{then } r + s = \mathfrak{D}\ ;$$
$$SD''' = SM + MD''' = r\sin 2z + s\sin 2z\ ;$$
$$\therefore\ SD''' = (r+s)\sin 2z = \mathfrak{D}\sin 2z.$$

$$D'''B = \mathfrak{B}\sin z\ ;\ BC = \mathfrak{C}\cos z\ ;$$
$$\therefore\ LR = \mathfrak{A} + \mathfrak{B}\sin z + \mathfrak{C}\cos z + \mathfrak{D}\sin 2z + \mathfrak{E}\cos 2z.$$

Again, $OL = OP + (WG - WP) + (GH - LH)$, G being the point where the horizontal line from D' cuts the vertical axis.

But $$OP = 1\ ;\ WG = E'S + D'''D'' = r\cos 2z + s\cos 2z$$
$$= (r+s)\cos 2z = \mathfrak{D}\cos 2z.$$

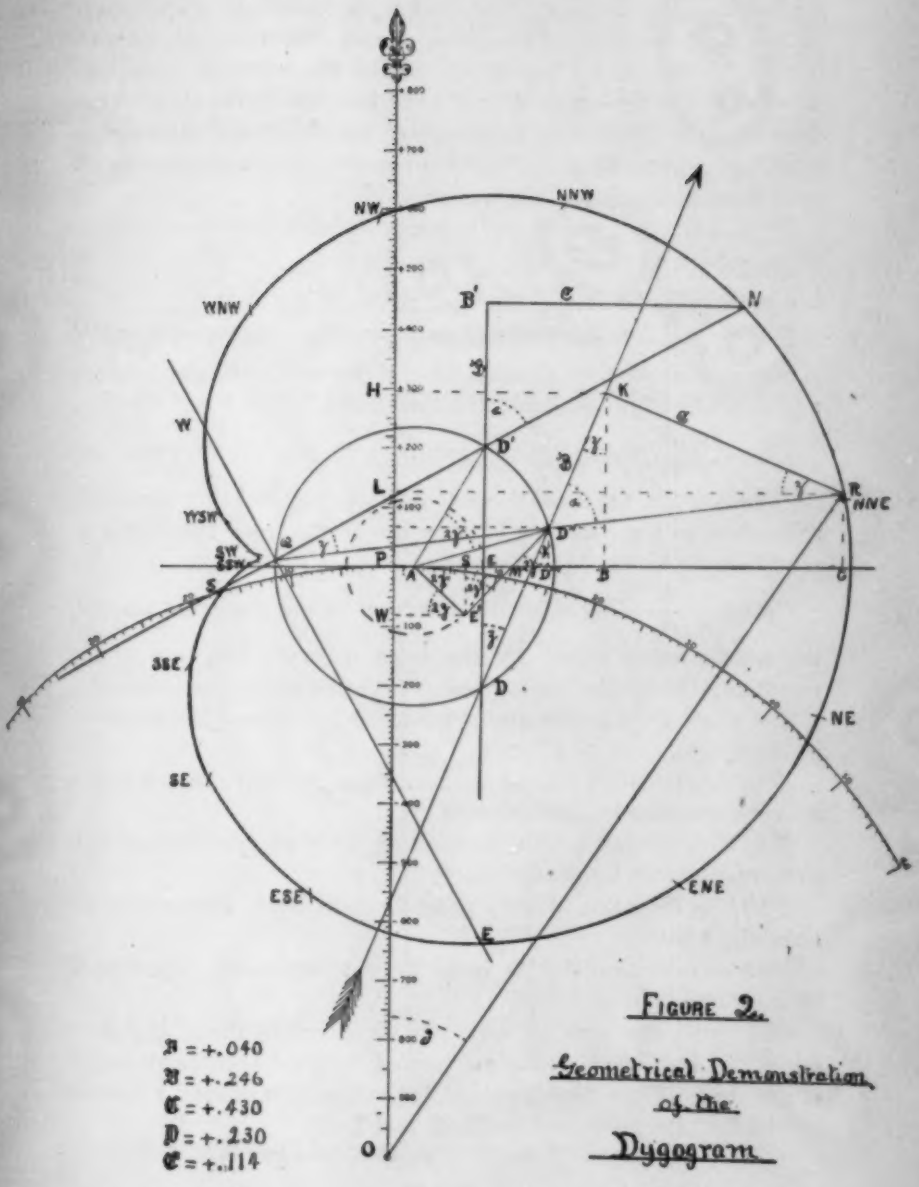
$$WP = \mathfrak{E}\sin 2z\ ;\ GH = \mathfrak{B}\cos z\ ;\ LH = \mathfrak{C}\sin z\ ;$$
$$\therefore\ OL = 1 + \mathfrak{B}\cos z - \mathfrak{C}\sin z + \mathfrak{D}\cos 2z - \mathfrak{E}\sin 2z.$$

$$\text{Hence } \tan\delta = \frac{\mathfrak{A} + \mathfrak{B}\sin z + \mathfrak{C}\cos z + \mathfrak{D}\sin 2z + \mathfrak{E}\cos 2z}{1 + \mathfrak{B}\cos z - \mathfrak{C}\sin z + \mathfrak{D}\cos 2z - \mathfrak{E}\sin 2z}.$$

The line NS, although taken as the zero line for laying off the magnetic headings, does not represent the direction of the keel line of the ship for magnetic north or south. The vertical line represents the keel line for magnetic north or south (magnetic meridian) and the direction for any other heading z is represented by drawing from D (vertically below E), a line $DD''K$ making an angle $z = D'DD''$ with the vertical. As $\mathfrak{B}$ is laid off to head and $\mathfrak{C}$ to starboard (opposite, if negative), the angle $B'D'N = KD''R = a$ (the starboard angle).

It must be seen that the points marked on the curve of the dygogram are not really directions of the ship's head. but are the points on the curve which show, for the headings designated, the deviations of the compass and the position of the forces in regard to the meridian, for those headings.

To represent the direction of the ship's head on the dygogram



A = +.040
B = +.246
C = +.430
D = +.230
E = +.114

FIGURE 2.

Geometrical Demonstration of the Dygogram

for any designated point of the curve, join the point on the curve with Q and note the intersection of this line with the circumference of the generating circle; a line drawn from D through this point of intersection will give the keel line of the ship. Confusion may be avoided by drawing around the point of intersection with the generating circle the outlines of a ship with its head in the proper direction.

OP = unity = mean force to north = mean directive force in the compass needle = λH. Where λ is unity, the mean force to north becomes H, the horizontal force of the earth at that place.

$OL = \frac{1}{\lambda}\frac{H'}{H}\cos\delta$ = force of earth and ship to magnetic north, in terms of mean force to north as unit (for any particular azimuth z of ship's head) = directive force of needle.

$LR = \frac{1}{\lambda}\frac{H'}{H}\sin\delta$ = force of earth and ship to magnetic east (in terms of λH, the mean force to north as unit, for any particular azimuth z) = force tending to draw the needle from the magnetic meridian, thus causing deviation.

$OR = \frac{1}{\lambda}\frac{H'}{H}$ = force in the direction of the disturbed needle; the needle being drawn by the force to east (LR), out of the meridian, through the angle $POR = \delta$ for that particular azimuth z.

The angle POA = deviation due to constant force $\mathfrak{A}$ (same for all headings).

AOE' = deviation due to induced force in unsymmetrical soft iron, represented by coefficient $\mathfrak{E}$.

$E'OD'$ = deviation due to induced force in symmetrical soft iron, represented by coefficient $\mathfrak{D}$.

$D'OK$ = deviation due to polar force to head, represented by coefficient $\mathfrak{B}$.

KOR = deviation due to polar force to starboard, represented by coefficient $\mathfrak{C}$.

Of course, the sum of any two or more of these angles is equal to combined deviation caused by the combined forces designated. Thus the deviation for magnetic azimuth z caused by the forces represented by $\mathfrak{A}$, $\mathfrak{E}$ and $\mathfrak{D}$ is

$$POD' = POA + AOE' + E'OD''.$$

A correct idea of what the dygogram is may be obtained from the

following, viz. : Suppose a compass needle pivoted at O (see Fig. 2), its half length when equal to OP being considered as unity, that is, equal to the mean force to north, λH. Suppose the needle capable of assuming a length proportional to the force in the direction of its length, for each heading. From an inspection of the dygogram, it is seen that the force in the direction of the needle $\left(OR = \frac{1}{\lambda}\frac{H'}{H}\right)$ varies in amount or length as the ship swings in azimuth. Now, as the ship swings in azimuth, through a complete circle, the end of the needle will trace out the curve of the dygogram, its end, at any azimuth z being at the point R of the dygogram, showing a deviation $\delta = POR$.

TO SHOW HOW EACH FORCE ACTS TO PRODUCE A DYGOGRAM AS THE SHIP SWINGS IN AZIMUTH.

Take each one separately, the others being supposed to be zero.

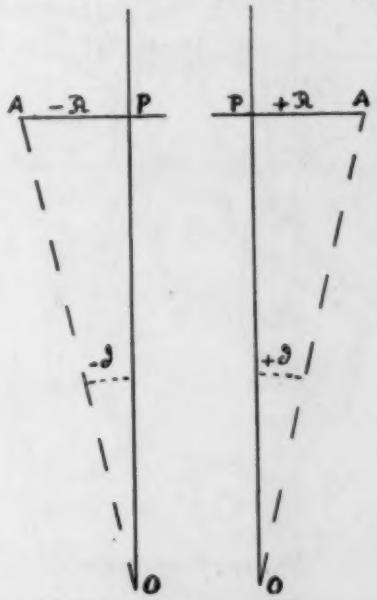


FIG. 3.—COEFFICIENT 𝔄.

Coefficient 𝔄.—The general expression becomes

$$\tan \delta = \mathfrak{A}.$$

From P lay off $PA = \mathfrak{A}$, to the right if +, to the left if—. Then

the line AO will make a constant angle with the vertical for all headings, this angle being the deviation due to $\mathfrak{A}$, and being such that $\delta = \tan^{-1} \mathfrak{A}$.

Coefficient $\mathfrak{E}$.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{E} \cos 2z}{1 - \mathfrak{E} \sin 2z}.$$

From P lay off $PN = \mathfrak{E}$, to the right if $+$, to the left if $-$ (as $\mathfrak{E}$ represents a transverse force when heading N.). With P as a center and a radius equal to $PN = \mathfrak{E}$, describe a circle; this represents the dygogram for force $\mathfrak{E}$. As $\mathfrak{E}$ represents a transverse force, the N. and S. points will be to the right (if $\mathfrak{E}$ is $+$),

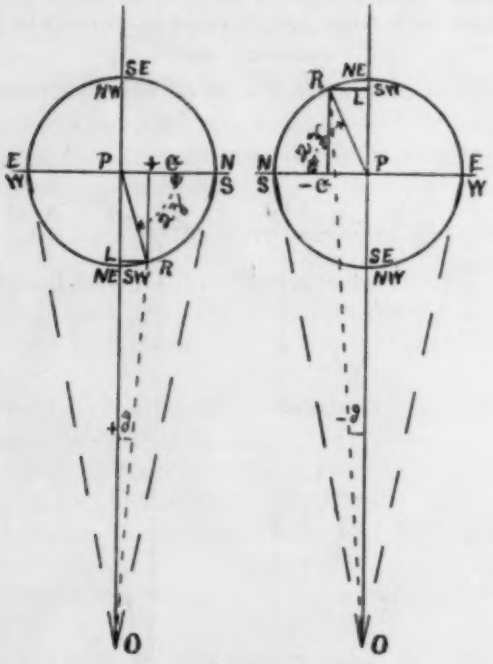


FIG. 4.—COEFFICIENT $\mathfrak{E}$.

the E. and W. points will be to the left, NE. and SW. points below, and SE. and NW. points above (all reversed if $\mathfrak{E}$ is $-$).

From the theory, it is known that as the ship swings in azimuth z, the force $\mathfrak{E}$ will vary as $2z$. Then, to find any point R of the dygogram corresponding to azimuth z, lay off from N, at center

P, an angle $NPR = 2z$, to the right. Join RO; then $\delta = POR$ (for azimuth z). For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{E} \cos 2z}{1 - \mathfrak{E} \sin 2z}.$$

From this it is seen that the deviation due to force $\mathfrak{E}$ is a maximum on cardinal points and zero on the intercardinal points, the maximum easterly being at N. and S. and westerly at E. and W. (reverse if $\mathfrak{E}$ is negative). It is also seen that the directive force is increased when heading SE. or NW. and decreased when heading NE. or SW. (reversed if $\mathfrak{E}$ is negative).

Coefficient $\mathfrak{D}$.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{D} \sin 2z}{1 + \mathfrak{D} \cos 2z}.$$

$\mathfrak{D}$ represents a force to head when heading north magnetic.

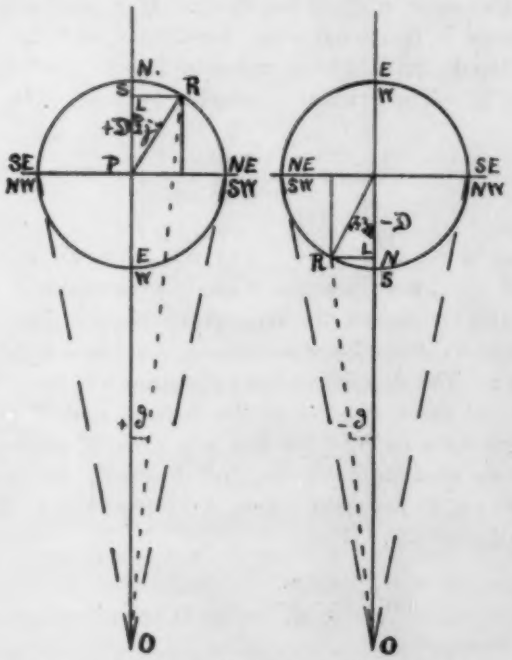


FIG. 5.—COEFFICIENT $\mathfrak{D}$.

From P lay off $PN = \mathfrak{D}$, upwards if + (as it generally is); and

with center P and radius equal to $PN = \mathfrak{D}$, describe a circle; this represents the dygogram for force $\mathfrak{D}$. As $\mathfrak{D}$ represents a fore and aft force when heading N., the N. and S. points will be above, the E. and W. points below, NE. and SW. points to the right, and SE. and NW. points to the left (all reversed for a $-\mathfrak{D}$).

To find any point R of the dygogram corresponding to azimuth z, lay off from N, at center P, an angle $NPR = 2z$, to the right. Join RO; then $\delta = POR$ (for azimuth z). For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{D} \sin 2z}{1 + \mathfrak{D} \cos 2z}.$$

From this it is seen that the deviation due to force $\mathfrak{D}$ is a maximum on intercardinal points, and zero on cardinal points, the maximum easterly being at NE. and SW., and maximum westerly at SE. and NW. (reversed if $\mathfrak{D}$ is negative). It is also seen that the directive force is increased when heading N. or S. and decreased when heading E. or W. (for $+$ value of $\mathfrak{D}$).

Coefficient $\mathfrak{B}$.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{B} \sin z}{1 + \mathfrak{B} \cos z}.$$

$\mathfrak{B}$ represents a force to head. Lay off $PN = \mathfrak{B}$, upwards if $+$, downwards if $-$, and describe a circle with centre P and radius $PN = \mathfrak{B}$; this represents the dygogram for force $\mathfrak{B}$. This being a polar force, its direction will vary as the azimuth of the ship's head, or as z. The N point of the dygogram will be at the top, the E point to the right, S point at the bottom and W point at the left (reversed for a $-\mathfrak{B}$). To find any point R of the dygogram corresponding to azimuth z, lay off from N, at center P, an angle $NPR = z$, to the right. Join RO; then $\delta = POR$. For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{B} \sin z}{1 + \mathfrak{B} \cos z}.$$

The deviation due to force $\mathfrak{B}$ is a maximum when heading E. or

W. and zero when heading N. or S., the maximum easterly being when heading E., and maximum westerly when heading W.

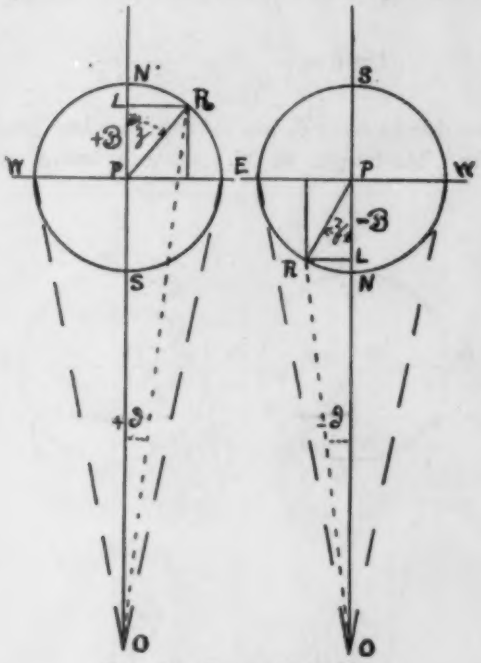


FIG. 6.—COEFFICIENT $\mathfrak{B}$.

(reversed if $\mathfrak{B}$ is negative). The directive force is increased when heading N. and decreased when heading S. (for + value of $\mathfrak{B}$).

Coefficient $\mathfrak{C}$.—The general expression becomes

$$\tan \delta = \frac{\mathfrak{C} \cos z}{1 - \mathfrak{C} \sin z}.$$

$\mathfrak{C}$ represents a transverse force. Lay off $PN = \mathfrak{C}$, to the right if +, to the left if —, and describe with center P and radius $PN = \mathfrak{C}$, a circle; this represents the dygogram for polar force $\mathfrak{C}$. This being a polar force, its direction will vary as the azimuth of of the ship's head, or as z. The N point of the dygogram will be to the right, the E point at the bottom, the S point to the left and the W point at the top (reversed if $\mathfrak{C}$ is negative). To find the point

R of the dygogram corresponding to any magnetic azimuth z, lay off from N, with center P, an angle $NPR = z$, to the right. Join RO; then $\delta = POR$. For, let fall perpendicular LR. Then

$$\tan \delta = \frac{LR}{OL} = \frac{\mathfrak{C} \cos z}{1 - \mathfrak{C} \sin z}.$$

The deviation due to force $\mathfrak{C}$ is a maximum when heading N. or S. and zero when heading E. or W.; the maximum easterly being

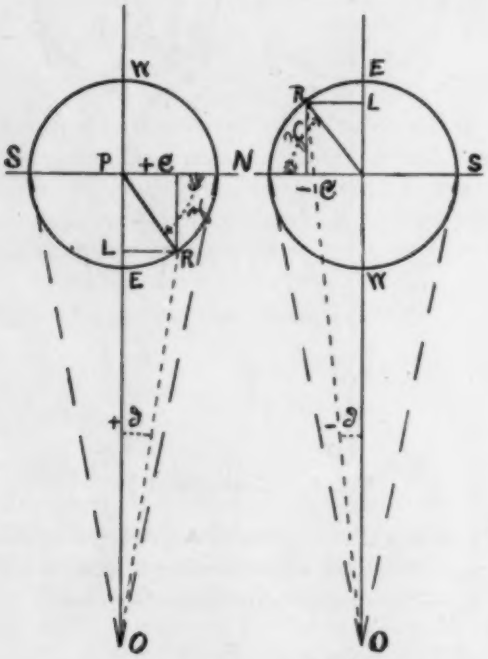


FIG. 7.—COEFFICIENT $\mathfrak{C}$.

when heading N., and maximum westerly when heading S. (for + value of $\mathfrak{C}$). The directive force is increased when heading W. and decreased when heading E. (if $\mathfrak{C}$ is +).

With a knowledge of the dygograms of the different forces acting on the compass, any case that will arise in practical compass work may be readily solved by combining them to suit the special case.

Example.—Suppose the values of $\mathfrak{B}$, $\mathfrak{C}$ and $\mathfrak{D}$ have been obtained, and it is desired to compensate while at the dock ("one heading" method). $\mathfrak{B} = +.450$; $\mathfrak{C} = +.250$; $\mathfrak{D} = +.200$; $z = S\,72°\,E.$

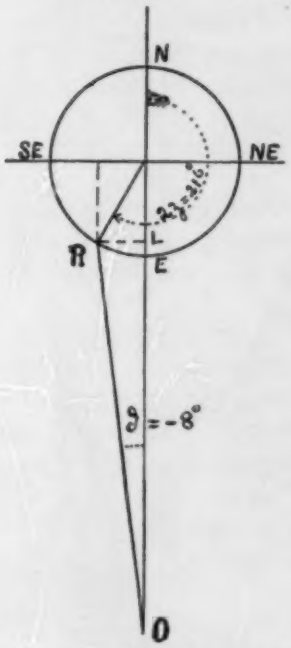


FIG. 8.

To Find δ *due to* $\mathfrak{D}$.—With center P and radius $= \mathfrak{D} = .200$, describe a circle and mark N at the top. Lay off NPR to the right $= 2z = 216°$ (z being $S\,72°E = N\,108°E$ and $2z = 216°$), which gives the point R; join OR, then $POR = \delta = -8°$. Now, in order to compensate for the polar force ($\sqrt{\mathfrak{B}^2 + \mathfrak{C}^2}$), the magnets should be placed in the tray in the proper position and moved up or down until the semicircular deviation has been overcome, that is, leaving an amount equal to the deviation caused by $\mathfrak{D}$ uncompensated.

$$\begin{aligned} z &= S\,72°\,E \\ \delta &= \quad 8°\,W \\ \hline z' &= S\,64°\,E \end{aligned}$$

The compass, before compensating the quadrantal, should then read $S\,64°\,E.$

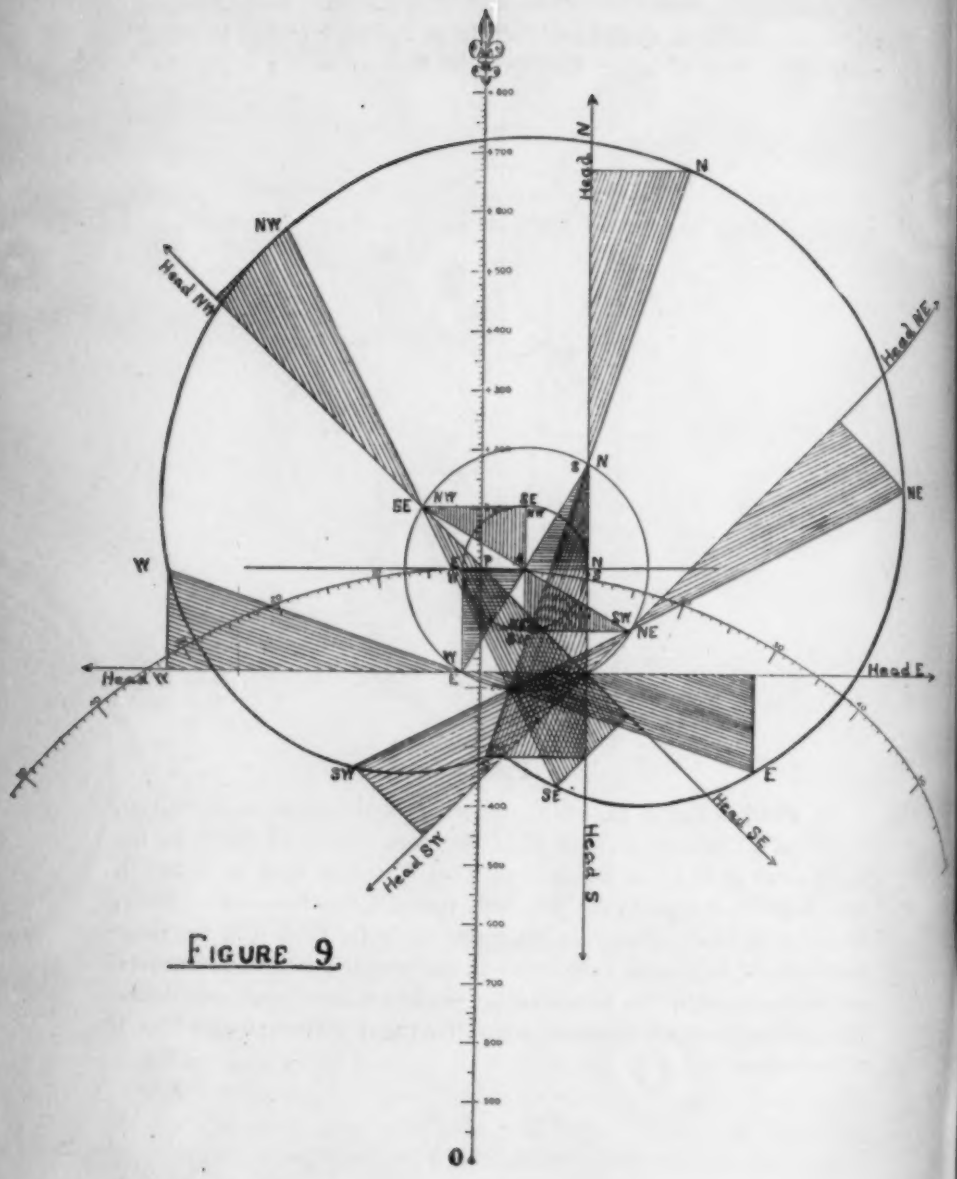

Head N
Head NE
Head E
Head SE
Head S
Head SW
Head W
Head NW
N
NE
E
SE
S
SW
W
NW
0

FIGURE 9.

By solving $\tan \delta = \frac{\mathfrak{D} \sin 2\varepsilon}{1 + \mathfrak{D} \cos 2\varepsilon}$, it would be found that $\delta = -8°$.

Various cases might be given where a knowledge of the dygogram would be of great assistance; such as where the values of $\mathfrak{A}$, $\mathfrak{B}$, $\mathfrak{C}$, $\mathfrak{D}$ and $\mathfrak{E}$ are all known, and it is desired to compensate on any heading while at the dock; in which case the deviation due to $\mathfrak{A}$, $\mathfrak{E}$ and $\mathfrak{D}$ has to be left uncorrected in compensating the semi-circular deviation, that due to $\mathfrak{A}$ and $\mathfrak{E}$ left uncorrected in compensating that due to $\mathfrak{D}$, or that due to $\mathfrak{A}$ left in compensating that due to $\mathfrak{E}$ and $\mathfrak{D}$.

Fig. 9 shows the manner in which the various forces revolve, by which the final curve of the dygogram is traced out, when all the forces have appreciable values as represented by the exact coefficients.

OP is equal to unity $= \lambda H$.

PA is the dygogram due to the constant force represented by $\mathfrak{A}$.

The inner circle is the dygogram due to the induced force represented by $\mathfrak{E}$, standing to one side of the meridian line on account of the constant force $\mathfrak{A}$; the circle is properly marked.

The next circle, having a radius equal to $\sqrt{\mathfrak{D}^2 + \mathfrak{E}^2}$, is the dygogram due to both induced forces, represented by $\mathfrak{E}$ and $\mathfrak{D}$, standing to one side of meridian line on account of the constant force $\mathfrak{A}$.

The small shaded triangle is the triangle of induced forces producing the quadrantal deviation, and revolves around A as center, the rate of revolution being double that of the ship in swinging.

The large shaded triangle is the triangle of polar forces producing the semicircular deviation; it revolves on the circumference of the quadrantal circle, its apex continually touching that of the inner triangle, the center of revolution being at the point D (see Figs. 1 and 2) and its rate of revolution being the same as that of the ship in swinging.

The final curve, that traced out by the outer corner of the triangle of polar forces, is the curve of the dygogram.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

NAVAL ORDNANCE.*

By P. R. ALGER, Professor of Mathematics, U. S. Navy.

Before entering upon the description of modern naval ordnance, which it is the object of this lecture to present to you, it will perhaps be instructive to briefly sketch the history of the gun and its development from the earliest times, and to mark those discoveries and inventions which have from time to time caused important steps in its progress.

Cannon seem to have been first used in war at the siege of Quesnoy, in France, in 1340. Froissart tells us that on this occasion the French were repulsed, their horses being frightened by the discharge of weapons which made a great noise and shot pieces of iron.

Villiani, a Florentine writer, says cannon were used at the battle of Crecy, in 1346. He states that the English used bombards which "with fire, throw little balls to frighten and destroy horses."

In 1347, cannon were undoubtedly used by Edward III. at the siege of Calais, but how different these cannon were from the guns of to-day may be imagined from the fact that three or four ounces of powder appear to have been the daily allowance, and the supply of projectiles only included 204 lead shot and twelve pieces of lead for 20 cannon.

In the latter part of the fourteenth century cannon began to be used at sea. At first galleys were armed with them, and carried

*The first of two lectures delivered before the Naval War College, Newport, R. I. The second lecture will appear in the next number of the PROCEEDINGS.

in the bow a piece called a Corsiere. Later sailing vessels were armed with bombards, cannon of small calibre, mounted on deck and firing stone shot over the rails.

In 1350, the Moors of Seville are said to have used cannon in a sea fight with the Moors of Tunis, and in 1387, for the first time, the French and English fought at sea with guns.

Early in the next century, gun ports are invented (the suggestion of Descharges, a ship builder of Brest), and the pierced sides of ships begin to bristle with cannon. By the end of the century we read of the building of a French ship, La Cordelière, the gift to France of the wife of Louis XII., carrying 60 guns, and of the English ship, The Regent, built to oppose her.

From specimens still extant we learn that these earliest cannon were either built up of wrought iron or cast of brass, that they were sometimes of great size and length, and that breech loaders were in common use.

A cannon of the reign of Henry VI. (1440), of caliber 4.25″, 7′ 6″ long, and weighing 8 cwt., is built up of wrought iron bars or staves over which 35 iron rings have been driven, a bronze cylinder inserted in the breech being used as a chamber—a forerunner of the Brown segmental gun of newspaper fame.

The cannon of Mahomet II., built in 1453 for use in the siege of Constantinople, were cast of brass and fired a stone ball of over 600 lbs. weight. Gibbon tells us that "under a master who counted the moments this great cannon could be loaded and fired no more than seven times in one day."

Yet larger cannon, firing stone balls of 1100 lbs. weight, are still to be seen on the coast of the Dardanelles.

The wrought iron cannon in Edinburg Castle, known as Mons Meg, was used at the siege of Dumbarton Castle in 1489, and was fired as late as 1682. It has a caliber of 20″, and fired a granite shot of 330 lbs. weight.

In 1836, the guns were recovered from the Mary Rose, sunk in action with the French off Spithead in 1545. They are of wrought iron and of brass, the former of 8″ caliber and breech-loading. These breech-loaders were loaded by removing a breech-piece, putting the charge in it, putting the shot in the gun, replacing the breech-piece, and securing it by wedging from the rear. The Armstrong breech-loading guns, adopted by England in 1859, and

of which 3500 were built, only to be abandoned in favor of muzzle-loaders a few years later, were much of this same pattern.

A gun in Dover Castle, made in 1544, is of 4.75″ caliber, firing a 12-lb. shot, and has a length of 53 calibers, rivaling the latest guns of the present time.

Iron shot came into use about the middle of the fifteenth century, although stone shot continued to be used for a long time still. About the middle of the next century, the sixteenth, cast iron began to be used for guns, and for the next 300 years was used almost exclusively, as it made the construction of guns more simple, rapid and cheap.

Rifling must have been proposed this early also, for at Woolwich is a barrel, dated 1547, rifled with six grooves, of a twist of one turn in 26 inches and fitted for breech-loading. Thus we see that it has taken over 300 years to develop these two ideas—breech-loading and rifling—to perfect the inventions which form the essential features of our modern guns.

The extent to which guns were used at sea by the end of the sixteenth century may be learned from the records of the armament of the Spanish ships of the invincible Armada. There were 130 ships, carrying 2431 guns, most of which were very small—4, 6, and 10-pdrs. The two largest Spanish ships were the S. Lorenzo and Nuestra Señora del Rosario, armed, the first with four 60-pdrs., eight 30-pdrs., six 18-pdrs., six 9-pdrs., ten 6-pdrs. and sixteen small guns, or fifty guns in all; and the second with three 30-pdrs., seven 24-pdrs., four 18-pdrs., one 9-pdr. and twenty-six small guns, or forty-one guns in all; while the Triumph, the largest English ship, carried four 60-pdrs., three 30-pdrs., seventeen 18-pdrs., eight 9-pdrs., six 6-pdrs. and thirty small guns, or sixty-eight guns in all.

The Spanish accounts, speaking of the rapidity of the English fire, estimate it at three times their own; but the crude character of the guns, their ill-fitting projectiles, and the small size of the gun-ports, preventing train or depression, made the effects of their fire slight. Sir Wm. Wynter, who commanded a part of the English fleet, writes, "The fight continued from nine of the clock till six of the clock at night, at which time the Spanish array bore away NNE., or N. by E. as much as they could, keeping company one with another. . . . I deliver it to your honour upon the

credit of a poor gentleman that out of my ship there was shot 500 shot of demi-cannon (30½ lbs.), culverin (17½ lbs.) and demi-culverin (9½ lbs.); and when I was furthest off in discharging any of the pieces, I was not out of shot of their Harquebus, and most times within speech of one another; and surely every man did well. No doubt the slaughter and hurt they received was great, as time will discover it; and when every man was weary with labor, and our cartridges spent and munitions wasted—I think in some altogether—we ceased and followed the enemy." He does not speak of any great slaughter of his own men, and doubtless there was less than he imagined among his opponents.

The state of naval ordnance at this time, and for a century later, may be learned from the following quotation from Sir Jonas Moore, who wrote in 1689: "At sea the ordnance are mounted upon small carriages, and upon four, and sometimes two low wheels without any iron work. Each gally carries ordinarily nine pieces of ordnance in its prow or chase, of which the greatest, and that which delivers his shot just over the very stem, and lies just in the middle, is called the Corsiere or cannon of course, or chase cannon, which in time of fight doth the most effectual service. It carries generally a shot of 33 lbs. or 34 lbs. weight, and are generally very long pieces; it recoils all along the middle of the gally to the mast, where they place some soft substance to hinder its further recoil that it might not endammage the mast. Next to this Corsiere are placed two Minions on each side, which carries a 5 or 6-lb. ball; and next to these are the Pitrieroes, which are loaded with stone shot to shoot near at hand. Thirdly, there are some small pieces, which are open at the breech and called Pitrieroes à Braga, and are charged with a moveable chamber loaded with bar shot, to murder near at hand. And the furthest from the Corsiere or chase cannon are the Harquebus à croc, which are charged with small cross-bar shot, to cut sails and rigging. All these small pieces are mounted on strong pins of iron having rings in which are placed the trunnions, with a socket so that they are easily turned to any quarter." . . . And again, in reference to larger vessels: . . . "All the guns are mounted upon wheels and carriages; moreover, the Pitrieroes, which are planted in the forecastle and quarter to defend the prow and stern, are mounted upon strong pins of iron without any reverse; the

greatest pieces of battery are planted the lowest, just above the surface of the water; the smallest in the waist and steerage; and with the Pitrieroes in quarter-deck and forecastle. Upon the sea, to load great ordnance they never load with a ladle, but make use of cartridges, as well for expedition as security in not firing the powder, which in time of fight is in continual motion.

"All artillery are commonly reduced to three sorts: The first is that of the Culvering, the second Cannons of Battery, the third Cannons Petrieri. To offend afar off, in case of strong resistance, the Culverings do serve, which carries a ball of iron from 14 to 30 lbs. weight, though some make these to 120 lbs. As to caliber they are called Whole-Culvering, Culvering, and Demi-Culvering. The Whole-Culvering are called anciently Dragon-Drakes, and carry a ball of iron from 40, 50 to 60 lbs., etc. The Culvering from 35, 30, 25, 20 lbs. . The Half-Culvering from 18, 16 and 14. As to length, they distinguish the Culvering into ordinary, extraordinary and bastard. The ordinary Culvering are long from the touch-hole to the muzzle, 32 calibers. The extraordinary are longer than the ordinary, viz., to 39, 40 and 41 calibers. The bastard are shorter than the ordinary, viz., only 28, 27 and 26.

"The Cannons of Battery are pieces ordinarily shorter than Culverings. The One-fourth-Cannon carries a ball of iron from 16 to 18 lbs. The Demi-Cannon from 20 to 28 lbs. The Cannon from 30, 40, 45 to 50 lbs. The Whole-Cannon from 70 to 120 lbs. The Cannon-Royal from 130 to 150 and 200 pound ball, used by the Turks. The Pitrieroes are so called from its ball of stone, with which they are loaded, from 2 to 100 and 150 lbs."

In the seventeenth century no special advance seems to have been made in the character of naval ordnance, but the gun-power of individual ships was increased. Since victory on sea, as well as on land, is the result of bringing to bear at the point attacked a force sufficient to crush the enemy at that point, the advantage of vessels of great individual artillery power became evident, and this power was sought in the greatest possible increase in the number of guns carried. In 1737, the first English three-decker, the Royal Sovereign, was built, carrying nearly 150 guns.

Early in the eighteenth century, the method of boring guns instead of casting them solid came into use, adding materially to the efficiency of the gun.

In 1742, Robins published his "Gunnery," invented the ballistic pendulum, the first means of measuring velocities, and pointed out the advantages of rifling and the use of elongated projectiles. In his "New Principles of Gunnery," he says: "Whatever State shall thoroughly comprehend the nature and advantages of rifled barrel pieces, and, having facilitated and completed their construction, shall introduce into their armies their general use, with a dexterity in the management of them, they will, by this means, procure a superiority which will almost equal anything that has been done at any time by the particular excellence of any one kind of arms." But he was in advance of his age, and a century was to elapse before the principles which he laid down were put in practice.

At the end of the 18th century, and during the wars of the French Revolution, the heaviest guns in common use were the long 32-pdrs. and the 42-pdrs. of 55 and 57 cwt., respectively. The advantages of large caliber, however, were not unrecognized, as shown by the use of carronades, so called from the village of Carron, where they were first made in 1774, but these were very short guns, only suitable for close range. Of them the largest, the 68-pdr. or 8-in. only weighed 36 cwt.

The battery of the Victory, Nelson's famous ship, was thirty 42 and 32-pdrs., thirty 24-pdrs., forty 12-pdrs. two 68-pdr. carronades, or 102 guns in all. These guns were mounted on wooden truck carriages. Elevation was given by handspikes, a quoin, or wedge-shaped piece of wood, being pushed in to hold the breech up. The slow match was usually used for firing, flint locks, introduced by Sir Charles Douglas, in 1782, being an important improvement. Sighting was by what was called the "line of metal," *i. e.* running the eye along the exterior of the gun and making allowance for the inclination of this line to the axis of the bore, due to less thickness of metal at muzzle than at breech.

In 1801 a proposal to use sights on naval guns was sent to Lord Nelson for an opinion, which was unfavorable, as follows: "As to the plan for pointing a gun truer than we do at present, if the person comes, I shall, of course look at it, or be happy, if necessary, to use it, but I hope we shall be able as usual to get so close to our enemies that our shot cannot miss the object."

Fixed sights came into use about the beginning of this century,

but the present system of one fixed and one movable sight, attributed to Col. Jure of the French Army, was not adopted till much later. Sir Howard Douglas, in his "Gunnery" (1829), gives a table of the parts of ships to be aimed at in order to hit them at different distances, and the method was to commit this to memory.

We now come to that invention which almost as much as any other one cause has revolutionized naval warfare and produced our modern battleships,—I refer to the introduction of the shell gun. For more than a third of a century the idea of firing shells horizontally had been entertained by some of the most prominent artillerists, and it had been sufficiently tested to prove that a means of offense was at disposal which for naval purposes was more destructive than any known, but the claim to the distinction of having devised and introduced the naval shell system is everywhere admitted to belong to General Paixhans.

The increase of the individual power of ships by increasing the number of their guns had been carried to the highest point. In 1817 England had 20 three-deckers, and of 18 ships-of-the-line building in 1821, five were of 120 guns. In France, out of 49 ships afloat in 1820, ten were three-deckers, and of 9 building, four were three-deckers. The same scheme had been followed in the smaller ships, and by placing ports as close together as possible and mounting guns in every available place, reducing the height of decks, and lightening as much as possible guns and carriages, frigates were made to carry 60 and even 80 guns.

But this idea of obtaining superiority over the enemy by the number of guns began to yield to the more reasonable idea of reaching this superiority by an increase in caliber. The destructive effect of the fire of a large gun is greater than that of several small guns, and lack of mobility upon the sea is not an obstacle to the use of heavy guns as it is on land. It was generally thought that 32 and 36-pdr. guns were as heavy as could be conveniently worked at sea, but the idea of increasing caliber without increasing weight was gaining ground. It was contended that long and heavy guns were only superior at long range and that it was not reasonable to prefer superiority of long range fire, which is unimportant, to that of close range, which is decisive. The result had been the introduction of the carronade.

In 1782, the Rainbow was armed entirely with these guns,

twenty 68-pdrs., or smashers, twenty-two 42-pdrs., and six 32-pdrs., and this vessel caused the French frigate Hebe, armed with 18-pdr. long guns, to surrender at the first broadside, in Sept., 1782. In 1796, the Glatton had smashers for the entire battery of her lower deck, and is said by their means to have beaten off with great loss a French squadron of 3 frigates and 3 corvettes. But it was found that an armament of these short guns had serious disadvantages. For example, in Sept., 1813, the English vessels on Lake Ontario were held at a distance by the American ships, which were armed with long 32-pdrs. and were unable to get within the range of their carronades.

The action of the Phoebe with our Essex is another illustration. Captain Porter says: "The Phoebe by edging off was enabled to choose the distance which best suited her long guns, and kept up a tremendous fire, which mowed down my brave companions by dozens. The enemy from the smoothness of the water and the impossibility of reaching him with our carronades, was enabled to take aim at us as at a target; his shot never missed our hull, and my ship was cut up in a manner which was perhaps never before witnessed."

General Paixhans saw the weakness of the short gun firing shot and saw the great advantages to be gained by the use of explosive shell from them. He also saw the power of large caliber and accordingly, in his "Nouvelle Arme," published in 1821, he laid down the following propositions: (1) "Of all the improvements tending to increase the effects of naval artillery that which will give incomparably the greatest power will be the abandonment of solid shot and the substitution therefor of hollow shell charged with powder to explode them;" (2) "although increase of power, by increase of caliber, has progressed for a long time, the *maximum* increase of power has not yet been attained;" (3) "although simplification by reduction of the number of calibers has progressed for a long time, unity of system has not yet been attained, but this unity of system will result from the attainment of the maximum power." In other words, he advocated the use of but one caliber for each ship, that the largest practicable, and the use of shell instead of shot. The progress towards the end which he proposed is shown by the following statement which he makes:—A French ship-of-the-line used to carry twenty-eight 36-pdrs., thirty 18-pdrs.

sixteen 8-pdrs., or 74 guns of three calibers firing 1746 lbs. of shot. Afterwards, and till the end of the Wars of the Revolution, twenty-eight 36-pdrs., thirty 18-pdrs., fourteen 8-pdrs., ten 36-pdrs., carronades, or 82 guns, still of three calibers, firing 2106 lbs. of shot. In 1819, twenty-eight 36-pdrs., thirty 24-pdrs , thirty-six 36-pdrs., carronades, or 94 guns of two calibers, firing 3159 lbs. of shot.

The greatest artillery power attained up to that time was that of a three-decker carrying 126 guns of various calibers all together firing about 3000 lbs. of shot. By substituting for the smaller guns, guns of 36, of the same weights as the guns they replaced, a uniform caliber would result and a weight of shot of 4600 lbs.; and with the same weight of guns, a uniform caliber of 48 could be used, firing the same weight of shell, as before of shot.

The effect of Paixhans' publication was the almost immediate introduction of shell guns into common use. In 1837, the French by general regulation established the shell gun as an element of all naval batteries, and in 1839, the English did the same, but it was in the United States, as will be seen later, that Paixhans' ideas were carried to their logical conclusion with the result of giving us the most powerful ships of their day.

It was not till 1832 that an efficient percussion lock and primer were introduced into the French Navy, and it was still later that the flint lock was given up by the English. In our own Navy percussion locks were fitted to the Vandalia's battery in 1828, but they were not exclusively used till 1842.

The rifled cannon first made its appearance in service on French and English ships during the Crimean War, and, though at first crude in design and faulty in construction, showed so many points of superiority over the smooth bore gun of corresponding weight, that its development was rapid.

In France, cast iron, lined and hooped with steel, was the construction used up to 1875, and the slotted screw breech closure, an American invention, was adopted from the first, and has been used without material change since.

In England, the Lancaster gun was first tried, of cast iron, with a bore of elliptical section, but twisted so as to give a projectile of the same shape the necessary spin to keep it point on. Much was expected of these guns, but the projectiles frequently jammed and broke up in the bore, and the system was only good enough to

point the way to better things. Sir Joseph Whitworth about the same time proposed his well known system, a mild steel gun with a twisted bore of hexagonal section. The Armstrong gun was, however, considered the best, and that system was adopted by the English Government.

The Armstrong guns were built up of wrought iron tubes, with wrought iron coils shrunk over them. They were breech loading, and used lead-coated projectiles. The breech closing arrangement consisted of a block or plug placed in a slot in the breech of the gun, and screwed up against the end of the barrel by a hollow screw, through which the gun was loaded. The obturation was effected by a copper ring on the front of the breech-block coming in contact with a copper face on the rear end of the tube. About 3500 Armstrong guns of calibers from 2.5 to 7 inches were manufactured between 1859 and 1863, but the system was fatally defective, and in a few years they were all abandoned, and guns built up in the same way, but muzzle loading, were adopted in their place, a step which had to be retraced 15 years later.

In Prussia, the Krupp system, in which a sliding wedge closes the breech, the Broadwell ring giving obturation, was first adopted and still remains in use. The Krupp guns were first made in one piece of crucible steel, cast, but later were built up of crucible steel forgings.

In Russia, the Krupp system was first taken up, but recently the slotted screw breech closure has been adopted, at least for the larger guns.

In our own country, the genius of Dahlgren and Rodman led to such a development of the smooth bore shell gun that the general use of rifled guns was postponed for many years. The 9, 11 and 15-inch Dahlgren guns were much superior to any previous smooth bores and even to the contemporary European rifled guns. Their superiority was due to a better distribution of the metal to withstand the firing strains and also to the superior quality of American cast iron. Admiral (then Lieut.) Dahlgren, carrying General Paixhans' ideas to their logical conclusion, proposed that the armament of all vessels of war should consist of the largest caliber guns which could be handled at sea, and having proved by experimental practice that the IX.-in. gun in broadside and the XI.-in. gun on a pivot mounting, could be readily con-

trolled and rapidly loaded and fired, he urged the exclusive use of these guns on our frigates. The crowning result of his labors was the Wabash class, armed with forty-two IX.-in. shell guns in broadside and two XI.-in. and two 100-pdr. Parrott rifles on the spar-deck in pivot. Dahlgren's proposition was to have six XI.-in. in pivot, but to this extent he was overruled.

The Parrott muzzle loader, of cast iron hooped with wrought iron, was the only rifle introduced into our Navy during the Civil War, and between that time and 1882 a few 8" muzzle loading rifles, converted from the XI. in. smooth bore constituted the only further addition to our naval armament. Abroad, however, the smooth bore had been entirely superseded, and everywhere except in England, where they still clung to the inferior Woolwich muzzle loader, the built-up steel breech loading rifle was in common use.

We have now reached a period when the development in ordnance and the general advance in naval construction became so rapid that it may be said without exaggeration that the progress of the last 35 years has exceeded that of the previous 500. At the outbreak of the Crimean War, ships and guns were, after all, but little different from those which had been in use for centuries, but since then, the use of steam as a motive power; the introduction of the shell gun and the consequent forced use of armor-clad ships; the application of the rifle principle to cannon, and the immense advances in our knowledge and skill in the manufacture of metal and explosives, have resulted in an entirely new material, whose powers, although we are as yet little familiar with them, we perceive to be vastly superior, offensively and defensively, to those of former times. Without, therefore, endeavoring to carry further my sketch of its development I shall now describe to you "Naval Ordnance" as it exists to day, and point out in what direction the road to further progress lies.

The modern naval gun is breech-loading, built up of a number of forged steel parts, assembled with shrinkage, the inner one forming the bore called the tube, and the others reinforcing this called jackets or hoops. The breech closure, either on the Krupp or the slotted screw system, usually engages in a jacket shrunk over the tube, though in some guns, notably French, it engages in the tube itself. The chamber, instead of being of reduced diameter as formerly, is of a diameter greater than the

caliber of the gun, so as to permit the use of a very large powder charge without unduly shortening the travel of the projectile. The length of bore is 30 calibers or more. The rifling consists of a large number of shallow grooves, usually of increasing twist, and rotation is imparted to the projectile by a copper or brass band of diameter slightly greater than the caliber, so that it is forced into the grooves as the projectile moves forward. The projectiles are common shell, either of cast iron or steel, containing large bursting charges; armor-piercing shell, of forged steel, usually without bursting charges; and shrapnel, containing a great number of small balls and a bursting charge just sufficient to open them and allow the balls to spread when the fuse acts. These projectiles weigh in pounds about one-half the cube of their caliber in inches, or about four times as much as the solid shot used in smooth bores of the same caliber, and, except the armor-piercing shell, are fitted either with percussion fuses exploding them on impact, or time fuses set to explode them after a given time of flight. The powder charges, when of black or brown powder, are about one-half the weight of the projectiles, and give muzzle velocities of upwards of 2000 f. s. When of the smokeless powders now coming into use, the charges are from one-quarter to one-third the weight of the projectile, and give muzzle velocities sometimes as high as 2600 or 2700 f. s.

Steel and iron carriages, with hydraulic cylinders for limiting recoil, are in universal use, the smaller guns being returned to the firing position automatically, either by springs or by the use of inclined slides, while for controlling the larger guns hydraulic power, and in some of the most recent designs electrical power, is used, thus doing away with the laborious and slow running out by hand required with the old guns and mounts. One of the most important steps in modern naval progress has been the development of rapid-firing guns, whose distinctive feature is the use of metallic cartridge cases similar to those used in small-arms, thus permitting loading in a single motion and rendering sponging unnecessary. Beginning about fourteen years ago with guns firing one, three and six pound shell, intended as a defense against torpedo-boats, the system has been extended until a large part of the battery of every modern ship consists of rapid-firing guns, some as large as six inches in caliber.

Another marked advance has been made in the improvement of the powder used in naval guns. The old black powder has been almost entirely superseded by brown or "cocoa" powder, so called from its color, which being more progressive in its action, can be used in larger charges, giving much higher velocities without dangerous pressures in the gun, and thereby increasing accuracy of fire at sea, where flatness of trajectory is all-important on account of the uncertain changing and distance of the target. Of late a new type of explosive has appeared, and is destined to replace brown powder, being already extensively used in small-arms and rapid-firing guns, and by the French even in guns of large caliber. This so-called "smokeless powder" consists essentially of a high explosive, gun-cotton, nitro-glycerin, or a mixture of the two, with its rapidity of burning diminished by giving it a dense, non-fibrous form, and by the addition of inert substances.

Range finders, range indicators, and electrical systems of communicating from a central station to all parts of a ship have given greater control over gun fire, and thereby increased its efficiency. Improved sights, exact methods of measuring the velocities of projectiles, and an increased knowledge of the laws governing the resistance of the air have added immensely to the accuracy of guns, and finally, the improvements in machine guns and the use of small calibers for them and for shoulder rifles, have so increased the offensive power of modern ships as to make the close range, long-drawn-out sea fights of former times an impossibility for the future.

The foregoing are the general characteristics of the modern naval ordnance material of all nations, but I shall describe somewhat more in detail the ordnance which is already in use and in contemplation for arming the ships of our own Navy, with only incidental reference to foreign guns, since this is not only the most interesting to us, but also may, I think, fairly be said to equal in efficiency the ordnance of any other naval power.

The guns constituting the main batteries of all vessels built or armed since the reconstruction of the Navy was begun are steel breech-loading rifles. The calibers thus far manufactured are 4″, 5″, 6″, 8″, 10″, 12″, and 13″. The system of construction and the method of manufacture are the same for all these guns. Each gun is built up of a number of forged steel parts, the 4″ and 5″

being composed of a tube, jacket and two chase-hoops, and the larger guns having a third layer of jacket-hoops and other chase-hoops, extending in some cases to the muzzle. These parts are assembled with shrinkage by heat.

The slotted screw breech mechanism is used in all these guns, the plug engaging in the jacket of the gun, and the gas-check being on the De Bange principle.

The forgings are made from open hearth steel ingots, cast solid, and weighing about twice as much as the finished piece required. For hoops, and sometimes for jackets and tubes, the ingot is bored and then forged on a mandrel; otherwise it is forged solid. After forging the piece is rough-bored and turned nearly to finished dimensions, but enough metal is left on one or both ends to allow taking test specimens. The rough-bored and turned forging is then annealed, oil-tempered, and again annealed, after which specimens are cut from the ends and tested. If these tests conform to the requirements in tensile strength, elastic limit and elongation, the forging is then accepted. Each forging is stamped with the caliber and part of gun, its own distinctive number, and the initials of the Government Inspector. The machining and assembling of the forgings are done at the Washington Gun Factory, the general process being briefly as follows: The complete set of forgings for a gun having been accepted, the shrinkages are calculated, using the lowest elastic limit shown by any specimen from each forging as the basis of the computations. The jacket forging is bored to the required diameter, the screw-box being only roughed out, and is then carefully star-gauged. While this is being done the hoops are also finish-bored and faced, and then star-gauged. The tube is first bored out nearly to finished size, and is then turned to a diameter at each point exceeding the interior diameter of the jacket at the corresponding point by the assigned shrinkage. The tube is then placed vertically in the shrinking-pit, and the jacket, having been expanded by heat, is lowered down over it and then allowed to cool. The assembled tube and jacket are then placed in a lathe and the tube is turned to the proper diameters for the chase-hoops, which are put on successively, each with its assigned shrinkage, after which the jacket is turned for the jacket-hoops, and they are put on in the same manner. The gun is then finish-bored, the chamber is bored out, the com-

pression and gas-check slopes are reamed out, the screw-box is threaded, and the exterior is finish-turned. Whenever, in machining, it is necessary to cut away the marks on a forging they are transferred to another part of the piece, so that in the finished gun each piece can be identified. Finally, the gun is rifled, the screw-box blanks are planed out, the breech mechanism is fitted, the gun is sighted, and, after proof-firing at the proving ground, is ready for issue to service.

Guns of each caliber are numbered from one up, and the different designs of each caliber are distinguished by the "mark," a new mark usually indicating a considerable change in the construction.

The calculated elastic strength of these guns over the chamber ranges from 18 to 24 tons, but pressures as high as 30 tons per square inch have been measured in powder tests and no permanent enlargement of the gun has been subsequently found. For service the chamber pressure is limited to about 15 tons per square inch, as the lifetime of the guns is greatly decreased by the use of excessive pressures, the main cause of deterioration being the erosive action of the powder gases near the seat of the projectile. For the same purpose of lengthening the gun's lifetime, and for economy, all except the R. F. guns are supplied with reduced charges, of about three-fourths the weight of the full charge, for use in target practice. The muzzle velocity given by this reduced charge is 1700 f. s. in guns of 30 calibers length of bore, and the sights are marked for this, as well as for the full charge velocity. The reduced charges are also used with shrapnel.

What the actual life of the new naval guns will be can only be estimated, but there is good reason to suppose that, for the smaller calibers at least, it will equal or exceed that of the old cast iron smooth bores. One of the Krupp 119-ton guns, built for Italy, after about 250 rounds was still in good condition, and there are records of the firing of a 12″ gun about 800 rounds without the erosion becoming sufficient to greatly decrease its velocity and accuracy. The smaller R. F. guns can be fired 2000 rounds and upwards before they become unserviceable.

The 10″, 12″ and 13″ guns are only mounted on armored ships, and in turrets or barbettes.

The 13″ gun weighs 61 tons and gives a projectile of 1100 lbs.

a muzzle velocity of 2100 f. s., equivalent to the perforation of 26.5 inches of ordinary steel armor. The muzzle energy of its projectile is 33,600 ft. tons, or sufficient to lift a first-class battleship 3 feet. At 2500 yards range its danger space for 20 feet freeboard is 213 yards, and its perforation in steel at the same range is 21.5 inches.

The 12″ gun weighs 45 tons and gives a projectile of 850 lbs. a muzzle velocity of 2100 f. s., equivalent to the perforation of 24 inches of ordinary steel armor. The muzzle energy of its projectile is 26,000 foot tons; its danger space for 20 feet freeboard at 2500 yards range is 209 yards, and its perforation in steel at the same range is 19 inches.

The 10″ gun weighs 25 tons and gives a projectile of 500 lbs. a muzzle velocity of 2000 f. s., equivalent to the perforation of 18.7 inches of ordinary steel armor. Its muzzle energy is 14,000 foot tons; its danger space at 2500 yards range is 180 yards, and its perforation in steel at the same range 14 inches.

For over a thousand yards range the danger space of all these guns is equal to the range, or, in other words, their projectiles will range upwards of 1000 yards without rising 20 feet, making a knowledge of the distance up to that point unnecessary.

It is considered of the utmost importance to manipulate guns by hand as far as is possible without great sacrifice of efficiency, and it has been found practicable to use hand power alone for working the breech closures of the heaviest of our guns by means of a mechanism designed by Lieut. F. F. Fletcher, U. S. N. This device is a simple improvement on the Farcot mechanism, long used with steam or hydraulic motor attachments in the French Navy, and is, I believe, simpler and better than any other mechanism in use anywhere. By its aid the 13″ breech mechanism, weighing 1947 lbs. can be opened and again closed in 35 seconds with two men on the crank, the gun being in the loading position, at 10° elevation, and one man can open and close it if necessary. The 12″ breech mechanism, weighing 1650 lbs. is opened and closed by two men in 25 seconds, or by one man in 30 seconds, and the 10″, by one man in 26 seconds. Consequently, as far as this operation is concerned there is little to choose between the three calibers.

The system of mounting is the same for all the heavy guns, and

is extremely simple. A steel slide, supported at its rear end by a hydraulic ram, is pivoted at its forward end to transverse girders secured to the turret floor. On this slide moves a saddle, to which the gun is secured by heavy steel straps. The forward part of this saddle is attached to the rod of a piston working in a cylinder secured between the slide rails. This cylinder is cut with shallow grooves of varying width, their sectional area decreasing to nothing at the rear end, and is full of water, so that when the gun recoils the water is forced from the rear side of the piston through the grooves to the front side, absorbing the energy of recoil and stopping the gun after about 4 calibers recoil. A pipe conveys water from the pumping system below to a water collar on the pivot of the slide and thence to the recoil cylinder, entering the latter by an automatic valve which closes when the pressure in the recoil cylinder exceeds the working pressure in the hydraulic system. Consequently when the gun recoils this valve closes, but, as soon as the recoil is checked, it opens and the gun is at once returned to battery. Two spring valves at the front end of the cylinder open during recoil to allow the water displaced by the piston rod to escape, but close again when the pressure falls to that of the system, 600 lbs. per square inch. With this system, it is evident that power is required for elevating the gun, since about half the weight of gun and slide rest on the elevating ram. A mounting has been designed for the 12″-guns of the Iowa, somewhat similar to that used for the R. F. guns, in which the slide itself is pivoted at the center of gravity of the system, permitting hand elevation, and in which the gun is returned to battery by springs. If successful, a similar design may equally well be used for the 13-inch guns, but I have, myself, some doubt as to the practical utility of using hand power to this extent. Motor power is absolutely essential for the rapid training of heavy guns, and I am inclined to think that it should also be used for elevation and running out.

For loading, the slide is dropped to a fixed loading position, usually extreme elevation; a three storied ammunition car, carrying the shell in the upper compartment and half the charge in each of the others, is hoisted in line with the breech by a hydraulic cylinder actuating a wire rope purchase, and the three parts of the cartridge are pushed home in turn by a sectional hydraulic rammer.

Motor power for hoisting the ammunition of heavy guns can

only be dispensed with at the expense of marked loss of rapidity of fire, and hand power is not therefore likely to be used for this operation. The ammunition hoists for the 10″, 12″, and 13″-guns are very efficient and practically work with the same ease and rapidity.

Much difficulty has been found in loading on account of the tendency of the shell to jam when the upper part of its head reaches the bore proper, especially when the residuum has not been removed from the seat of the shot. The hydraulic rammer, too, gives a great deal of trouble, buckling and leaking under the severe strains caused by the sudden stop of the shell when driven home. A sectional rammer whose parts screw in and out of one another and worked either by an electric motor, or by hand power, is in contemplation, and if worked out satisfactorily, will be a marked improvement. A pneumatic rammer worked from an air-flask is used on some English ships, but has the disadvantage of all pneumatic systems, the liability to explode if struck by a projectile. The greatest delay in loading the heavy turret guns is caused by the slow and difficult operation of getting the projectiles and powder, especially the former, from the magazines to the ammunition hoists, but in war time, of course, as much ammunition as possible would be gotten into the handling room, or turret chamber, beforehand, and the operation of getting it from there into the gun is a rapid one. We have as yet no experimental knowledge of the time required from one fire till the gun is again ready to fire, with the 10″, 12″, or 13″-guns, but I believe this time will be practically the same for all three calibers and will be, with well drilled crews, not over 3 minutes.

For rotating the turrets either steam or hydraulic power is used, the motors being sometimes on the turret floor, and turning a pinion gearing into a fixed rack, and sometimes on the deck below the turret floor and turning a pinion gearing into a rack on the turning turret. The revolving weight when a pair of heavy guns are mounted behind armor of reasonable thickness is so great that to train the guns by hand, except when the deck is perfectly level, would be out of the question with the ordinary systems of gun mounting. It is therefore thought that hand training gear is practically useless with our turrets and with guns above 8″ in caliber. In the Indiana's 13″-gun turrets, for example, the revolv-

ing weight is 504 tons; in the Puritan's 12″-turrets it is 280 tons, and in the Monterey's 10″-turrets it is 180 tons. In the 8″-gun turrets of the New York, Olympia and the battleships, however, where the revolving weights are only from 80 to 90 tons, alternate hand gear, for use in case the motor breaks down, is desirable and may be fairly efficient.

As regards rapidity of train, the Bureau of Ordnance requires with the heaviest turrets a speed of 360° per minute and with the lighter turrets a speed of 360° in 50 seconds, when the deck is inclined 10°, except in the case of the monitors, where the same speed is required with an inclination of deck of 5°.

The Terror's turrets are to be revolved by pneumatic motors, and the Brooklyn's 8″ turrets will probably be turned by electricity.

In considering the three motive powers, hydraulic, steam and pneumatic, the disadvantages of the hydraulic motor are expense and lack of efficiency as a machine; the disadvantages of steam are its elastic nature, which causes it to continue to act after the valves are closed, and its heating effects; and the disadvantages of compressed air are its elastic nature and the danger of explosion. Electricity has the disadvantage of its being very difficult to locate a fault. Steam, compressed air, and electricity, also, all require high speed motors and are very noisy. On the whole, however, I am of opinion that steam power is the best, provided that the motors are placed below the protective deck, which usually, if not always, can be done, and that proper ventilation is given to keep down the temperature.

A system of mounting, in which the turret is placed eccentrically to the fixed barbette over which it turns so that the centre of gravity of the revolving system is over the centre of the barbette, has been adopted on some recent French ships, and, with vertical rollers to give a central bearing, these turrets can be revolved by hand equally as well on an inclined deck as on the level, but hand power necessarily gives very slow train and is only useful as an alternate in case the motors are disabled.

The 10″, 12″, and 13″-guns, being mounted in turrets, have no sights attached directly to them, the sighting being done from a hood on top of the turret. The front sights are fixed in the edge of the turret top and the rear sight bars are held in boxes moved up and down with the gun by means of vertical rods geared into

circular racks on the brackets of the gun slide. The sight bars are set to the desired mark in the usual way. For some of the guns, the rear sight is fixed and the front sight moves with the slide. A great improvement upon this method of sighting, however, is in contemplation. The difficulty of bringing three moving points, the bottom of the sight notch, the tip of the front sight, and the target, into one line, is the real cause of most wild firing, and this source of error is entirely done away with when the sighting is by means of a telescope with cross wires in its field. With such an arrangement it is impossible to fail to point accurately, since the only requisite is to fire when the image of the target is at the junction of the two wires. The difficulty is to devise a means whereby the telescope, while not recoiling with the gun, shall be so attached to it as to indicate the angle between its own axis and that of the gun. It is thought that this will be accomplished, and if so, telescope sights will be applied to all turret guns.

The 8″ is the heaviest gun mounted on our unarmored ships, and also forms part of the main battery of the battleships. The 8″, of 35 cals. length of bore, the standard, weighs 13 tons, and gives a projectile of 250 lbs. a muzzle velocity of 2100 f. s. At the muzzle, the energy of its projectile is 7500 ft. tons, and it will pierce 13.3 inches of steel. At 2500 yards range, its danger space for 20 feet freeboard is 180 yards, and its perforation 10.7 inches of steel. The breech mechanism now used on the 8″-guns is the modified Farcot, just like that of the larger guns, and it can be opened and closed easily by one man in 9 seconds.

The gravity return central pivot carriage has been used principally with the 8″ guns, but a spring return mount like that used with the 4″, 5″ and 6″ R. F. guns is now being constructed and will be used hereafter. When the 8″-guns are mounted in turrets, as on the New York and the battleships, the ammunition is hoisted by a crane with a small motor, hand power being used if desired. Elevation and loading are entirely by hand. Training is by motor with alternate hand power. The time required from one fire until the 8″-gun is again ready should not exceed one minute, for on the statutory test of the first 8″, where the entire crew took shelter at each fire, ten rounds were fired in 15 minutes. Some delay is caused with this, as well as the larger guns, by the necessity of cleaning the seat of the shot, the scale otherwise sometimes causing the projectile to jam before it is home.

6″-guns have been used for the main batteries of most of our cruisers, mounted on central pivot gravity return mounts. The standard 6″-gun, of 30 calibers length of bore, weighs 4.8 tons and gives a 100-lb. projectile a muzzle velocity of 2000 f. s., piercing 10.2 inches of steel; at 2500 yds. range its danger space is 143 yds., and its perforation 6.2″ of steel. At a recent test at Indian Head, the 6″-gun was fired 10 rounds in 5 minutes 2 seconds.

Both the 6″ and 8″-guns have sights of the ordinary form fitted on both sides of the gun, the left-hand sight being only graduated to 4000 yds., and without a sliding head, while the right sight has a long bar graduated up to about 8000 yards, and with a traversing head for wind and speed corrections. I am of opinion that the use of the traversing head is undesirable. Corrections for wind and speed both being based upon estimates, it seems useless to lay them off on a graduated scale before firing instead of making the original estimate one of how much to point to the left or right of the target.

The advantages of the R. F. system can be partially extended to the 6″ caliber, and all our 6″-guns hereafter made will be of the R. F. type. The weight of the fixed ammunition, however, being about 170 lbs., precludes its use with one man to load, and consequently the cartridge case and projectile will be separate. The loaded cartridge weighs about 75 lbs. and its use gives more rapid firing because the gas check, either DeBange or Cup will sometimes stick and requires power with consequent slow motion in the breech closure; whereas, with the brass cartridge case a mechanism opening with a single motion of a lever can be used. With such a mechanism, the rate of fire will be increased to 10 rounds in 3 minutes, as was found to be the case recently at Indian Head. The mounting used with the 6″ R. F. gun is the same as that of the 4″ and 5″ R. F. guns.

We have now reached the calibers to which the rapid-fire system can be applied in its entirety. In the days of smooth bores it was found that the 9-inch shot weighing about 90 lbs. was the heaviest which could be conveniently handled by one man at sea, and, in the same way, the 5″ fixed ammunition weighing 95 lbs. is probably the largest which can be rapidly loaded, since the employment of two men for loading by interfering with the other operations, closing the breech, training and sighting, prevents the rapidity of fire which it is the object of fixed ammunition to secure.

The 5″ R. F. gun weighs 7000 lbs., and gives a projectile of 50 lbs. a muzzle velocity of 2300 f. s., equivalent to a perforation of steel of 9.4″. Its danger space at 2500 yards is 156 yards, and its perforation at that range is 4.6 inches of steel.

The 4″ R. F. gun weighs 3400 lbs., and gives a projectile of 33 lbs. a muzzle velocity of 2000 f. s., equal to 7.2 inches perforation of steel. Its danger space at 2500 yards is 119 yards, and its perforation at that range 3.7 inches of steel. The weight of the 4″ fixed ammunition is 58 lbs. The 5″ gun has been fired five rounds in 24 seconds, and the 4″, five rounds in 17 seconds.

Both these guns, and all the smaller R. F. guns are mounted so as to recoil in the line of fire, the recoil being checked by a hydraulic cylinder forming part of a sleeve screwed on to the gun in place of a trunnion band, and the gun being returned to battery by spiral springs. The slide, to which the piston-rod of the recoil cylinder is attached, is mounted on trunnions placed at the center of gravity of the system, the trunnion seats being in a steel carriage which revolves on rollers on a cone-shaped steel casting bolted to the deck. Elevation and train are very easy and rapid. The sights are on the left side of the slide, and consequently do not move in recoil. A telescope sight is being fitted to the later 4″ and 5″ mounts.

The lighter R. F. guns are either on the Hotchkiss or Driggs-Schroeder systems. The Hotchkiss R. C. 37-mm. and 47-mm. are still in service, but are so inferior to the lighter single-barrel guns that no more are to be issued. The calibers of Hotchkiss and Driggs guns are the 37, 47 and 57 mm., firing 1, 3, and 6-pound projectiles, but to reduce the number of calibers, the manufacture of 3-pdrs. has been abandoned for the future, and only 1 and 6-pdr. guns will hereafter be issued. The light 1-pdr., with a muzzle velocity of 1319 f. s., is also to be withdrawn from service, and the heavy 1-pdr., which has a muzzle velocity of 1800 f. s., is now the service gun of this caliber. All these guns are mounted on hydraulic recoil mounts similar to those of the 4″ and 5″ R. F. guns. This type of mount is the design of Lieut. F. F. Fletcher, and is equal if not superior to any other in use, being very simple, compact, and light.

The 3″ steel field gun, designed by Capt. Sicard 25 years ago, is still in use, but the Bureau of Ordnance will shortly issue a new

gun, of the same caliber and weight, but using fixed ammunition.

Finally, the machine-guns, which, I believe, are to play an important part in future naval engagements, are to be of the same caliber as has been adopted for the small-arm, 6 mm., or .236 inches. The muzzle velocity obtained from these guns will be upwards of 2500 f. s., and their steel-covered bullets will pierce almost if not quite one-half an inch of mild steel at close range.

At the present time percussion primers are used for firing all our service guns, with friction primers as an alternate, but the advantages of electric firing are so great as to cause its exclusive use in the near future. The Olympia's battery is the first fitted for electric firing, but as efficient electric primers, both for the guns of ordinary type and for the 4, 5 and 6″ R. F. guns, have been devised and are being made, it is hoped that within a short time this important improvement will be in use on all our ships.

For projectiles, we have excellent armor-piercing shell, of forged and tempered steel, capable of passing uninjured through two calibers of the best quality of steel armor, but the introduction of hard-faced armor has made still further improvement in this particular an urgent need. At ordinary velocities the present A. P. shell are smashed to fragments on the surface of case-hardened plates which they would easily perforate if of unhardened steel. Moreover, at even large angles of incidence A. P. shell are broken up by comparatively thin armor, being unfitted to withstand transverse strains. I believe, however, that this is but a temporary defeat, and that new methods will give us shell about as efficient against Harveyed plates as the present ones are against ordinary steel.

The common shell in use are of cast iron, cast steel, and forged steel; but here too there is room for great improvement. These shell break up on very thin armor plating instead of carrying their bursting charges through and exploding them on the other side. The type of shell which we are seeking to develop for all calibers is exhibited in the steel shell used for the Hotchkiss and Driggs guns, which will carry a considerable bursting charge through two calibers of soft steel. When we have 13″ shell which will carry 40 to 50 pounds of powder through even one caliber of armor, and such shell we hope to soon have, a great advance in the efficiency of our ordnance will have been made. The Schenkle

fuse is still used for most of our common shell of large caliber, but a base percussion fuse has been adopted as the standard, and all future common shell will be fitted with this.

Shrapnel have thus far been issued only up to the 8″ caliber, an efficient time fuse being still unfound, but experiments are being made with an entirely new type of base time fuse which promises well. Shrapnel with percussion fuses are very efficient on shore, and the new field guns will have no other projectiles. Shell containing high explosives are not yet in general use, though much talked of. The French alone have them in service. The real difficulty is to devise a safe fuse which will detonate them.

For all our guns, except the small R. F. guns, in which black cubical powder is used, brown prismatic powder alone is issued. Unfortunately we are not yet in a position to manufacture smokeless powder for service use, although promising results have been obtained experimentally with a gun-cotton powder made at the U. S. Torpedo Station. The difficulty is to obtain a powder which will not deteriorate in service, and the French alone have thus far had sufficient confidence in their smokeless powder to issue it to ships for use in large guns. The English cordite, a mixture of nitro-glycerin and gun-cotton, has been issued to the Channel squadron, I believe, for use in R. F. guns, but there is a well grounded fear of nitro-glycerin powders, and the reports of cordite are not all that would be desired by its advocates.

There is no doubt in my mind that the exclusive use of smokeless powder will be an accomplished fact before many years, and the effect of its adoption upon naval tactics will be great and lasting.

And now, in closing, let us note briefly what changes this immense progress in the efficiency of naval ordnance have brought about in the armaments of ships of war. It is a common idea that the modern battleship differs essentially from the ancient ship of the line in carrying few guns against the latter's many, but this is not so. It is true that the necessity for carrying very heavy guns, capable of piercing the armor of opposing battleships, has resulted in the practice of placing but four of these guns on a ship, but when the secondary battery guns are taken into account, and these are much more powerful than larger guns of former times, it will be found that the usual battery of a first-

class battleship comprises from 40 to 60 guns. For example, our Indiana, Massachusetts and Oregon each carry four 13", eight 8", four 6", twenty 6-pdrs., six 1-pdrs. and four machine guns, or forty six guns in all, with a weight of projectile of 5926 lbs., and a total muzzle energy of over 200,000 foot tons, sufficient to lift the battleship herself 20 feet into the air.

But while the battery of the Indiana class may be taken as typical of that of most other battleships, when we come to consider the various classes of cruisers, armored and unarmored, we find the greatest diversity. Ships of 8000 tons with batteries almost wholly of 4" or 5" guns, ships of 2500 tons carrying 10" guns, and ships of all sizes carrying all sorts of mixed batteries are the heterogeneous units of modern fleets. The stern test of war alone will definitely decide whose theories on this subject are the best, if practice be based on any theory, which I doubt; but it behooves us to carefully consider this subject and to endeavor to reach conclusions having at least the merit of being logical, and in a succeeding lecture I shall lay before you my views on this subject, with such arguments as I can adduce to support them.

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U. S. NAVAL INSTITUTE, ANNAPOLIS, MD.

CHANGES IN THE BATTLE EXERCISES OF THE FRENCH INFANTRY.

[*From Militär Wochenblatt.*]

Translated by H. G. DRESEL, Lieutenant, U. S. N.*

The instructions of January 3, 1889, for battle exercises of the French infantry have received certain modifications, and now stand substantially as follows:

In the attack, the firing will be delayed as long as possible; on the defensive, the fire will be opened vigorously as soon as it promises to become effective; in both cases, however, the available supply of ammunition must be considered, and a sufficient supply be withheld for the decisive moment. Before rapid fire or magazine fire is resorted to, effective results will be secured more by accuracy in aiming than by increasing the intensity of fire.

The chief of battalion will indicate the objective, and also that part of the enemy's line against which the fire will prove most effective. In case he fails to do this, or when conditions are suddenly changed, such duty devolves upon the chiefs of companies. They will designate the object, determine the distance, regulate the method of firing, number of rounds and commencement or cessation of firing. The chiefs of sections, together with the petty officers, will pay personal attention to the proper setting of the sights and the minute observance of the orders of the chief of company.

*These instructions differ but slightly in principle from those issued in 1891 by the Bureau of Navigation for use in the United States Navy.

In battle the aim will be directed at the foot of the object. For distances under 600 meters the sights will be set for 400 meters when the fire is directed at troops standing or marching; for distance under 800 meters, against cavalry, the sights will be set for 600 meters.

Volley firing is to be employed as long as possible in the attack as well as in the defense, and care taken to prevent desultory firing at will. Volleys by sections will be the rule; but volleys by platoons may be resorted to when overwhelming effect is possible or when closely massed troops offer a good target. If the enemy be driven from his position, volleys will prove most effectual in the pursuit and in preserving control over the men.

In general, volley firing is practicable against troops at distances not exceeding:—800 meters, at a line equal to the front of a squad of skirmishers; 1000 meters, at a line of the front of a half-section; 1200 meters, at a line of the front of a section or a piece of artillery; 1500 meters, at greater lines, columns of platoons, columns of companies, artillery or cavalry; 2000 meters at massed bodies of troops. These rules are not arbitrary, but admit of such departures as circumstances may dictate. Individual firing or fire at will, which is difficult of control, which, unlike volley firing, can be less easily concentrated, and which presents obstacles to an effective fire discipline, recommends itself, however, at short ranges when exposed to a vigorous fire from the enemy, with no time to resort to the more deliberate volley firing.

Rapid fire will be reserved for decisive moments.

Magazine fire is only employed by direct command from officers.

The magazines are to be filled before the battle formation. During the engagement, the expended cartridges are to be replaced in the magazines whenever opportunity offers.

Every troop of infantry must have its scouts. They are indispensable. The use of smokeless powder, the increased accuracy of the modern rifle, the flat trajectories, and the rapidity of fire, by hiding the enemy from view and by enormously increasing the fire-swept zone, have made the employment of cavalry scouts and patrols almost impossible. Only well organized and experienced infantry scouts, capable of taking advantage of every form of cover offered will be able to creep near enough to reconnoitre the enemy's position or to guard against surprises. Provided that the com-

plement permits it, each company will have 32 scouts in time of war, 16 in times of peace. Two scouts will be assigned to each group, but only one at a time to be sent out on active duty. The scouts should all be properly qualified for efficiently performing their work. The chief of battalion, or, in a company acting independently, the chief of company will determine whether the whole number or a part only of the scouts are to be sent out, and he will appoint a leader to take charge. Fundamentally they act only for their own company, but in exceptional cases they may act in combination with the scouts of the other companies of the battalion. The distance that they advance ahead of the main body will depend upon circumstances, but constant communication must be kept up with the main body, which preferably will supply files for these lines of communication. The scouts of two companies may support each other. In the field they will be afforded all possible relief and lightening of their camp duties. The qualifications of scouts will be entered upon their discharge papers. Their special education for this work will receive the particular attention of the chief of battalion. He will appoint an officer for this instruction, who will be assisted by a competent subordinate and two corporals in solving the proposed problem.

The rules for battle exercise of the company differ according as the company acts independently or forms part of a battalion, according as it is acting offensively or defensively. One particular point to be borne in mind is,—that the resolve to *win* is the best surety for ultimate success. The doctrine that "attack solely will secure victory" should be the basis of all military education and development.

When advancing through the enemy's country a company must protect itself against surprise by its scouts and flankers. With a strength of 200 rifles, its front will occupy an extent of about 150 meters. When forming part of a battalion and the order to advance is given, the chief of company will send out his scouts ahead, in the direction indicated by the chief of battalion; as soon as they have gained the proper distance, about 500 meters on level ground, the main body advances. The scouts remain actively engaged, advancing towards the front until the company has gained the objective point previously determined upon, where the chief of company will at once have every rifle in readiness. The advance will be conducted

rapidly, the company will take advantage of all cover offered by the nature and conformation of the ground to be traversed. Should the ground be open, the company will break into columns of sections or columns of platoons, with as great intervals between subdivisions as circumstances will allow. Should the enemy's fire cause considerable losses with such formations, to be expected at a distance of 1300 meters, the company will deploy into extended order, the guide being taken from the center with proper intervals. If no longer practicable to advance without firing, halt and open fire by volleys. The advance to be continued, however, as soon as possible. When within 400 meters of the enemy bayonets will be fixed and rapid fire ordered. If the enemy does not fall back, advance by short rushes, halt and keep up the rapid fire. When within 300 meters of the enemy and the latter continues to hold his position the fighting line will be reinforced by the supports, rapid fire is kept up until the charge is ordered, when officers and petty officers will place themselves ahead of the line and with the order "*charge*" will lead the assault. If, however, the chief of company judges that by a bold attack he can drive the enemy from his position, he will order the charge without waiting for the supports to arrive on the line. The position having been captured rapid fire will be directed at the retreating enemy. Should the attack be repulsed, the chief of company will rally his company as quickly as possible and renew the attempt; less loss will be sustained by such proceeding than if retreat were begun. The rally by sections will be the rule in such cases; if the men have become scattered or much mixed they will rally about the nearest officer or petty officer. The chief of company has no definite part in line; an aid and two orderlies will serve to carry his orders and to keep the chief of battalion informed of the state of the ammunition supply. In the deployment, section leaders will post themselves ahead of their sections; when fire is opened they take post in rear of their respective sections.

When the company is acting independently, the chief of company will see to the protection of his flanks and place in reserve a certain number of his men ready for any possible exigencies which may arise in battle.

The defense must always be vigorous, never passive. When forming part of a battalion the company may occupy a front of

200 meters. As soon as the position selected for defense is reached, the chief of company sends out the scouts, makes provisions for efficient ammunition supply, will personally reconnoitre the surroundings, will strengthen the position as much as possible by construction of defensive works, will assign each subdivision to the place it is to occupy, and will impress upon each the work it is expected to perform. As a rule, he will bring every rifle into play. The engagement will be opened by volley firing as soon as it will prove effective. The fire of certain subdivisions or parts of the line may be directed at the enemy's reserves. Counter attacks against the advancing enemy will be made by the reserve companies. If the enemy be repulsed energetic fire will be directed at his retreat; the company will at once assume the offensive. Should it become necessary to retreat, it will be conducted under the protective fire of the troops held in reserve to a position previously designated by the chief of battalion. Without definite orders, a position will never be abandoned except in the last extremity after the most stubborn resistance has failed.

When a company acts independently the same general principles will obtain, but the chief of company will always keep a part of his command in reserve.

The fighting line of a battalion on the offensive will be composed of one or more, generally two companies, the remaining companies being held in reserve. With a strength of 800 rifles in the battalion, the fighting line will occupy a front not to exceed 300 meters, regardless of the intervals from neighboring battalions. The attack of a battalion forming part of a larger body of troops is generally prepared for by artillery fire. When the chief of battalion has received the order to advance he will collect his chiefs of companies, chief of scouts, and possibly all of his officers about him and will give his directions and general instructions. If the advance is across covered or uneven ground, the companies on the fighting line will follow the same principles laid down for a company acting independently. The reserves follow under cover; circumstances will determine when and in what formation they will be sent to the front by the chief of battalion. Across open country the battalion will advance in extended double column with large intervals between echelons. The forward companies will advance the same as companies acting independently, sepa-

rated by intervals of 30 meters. The rear companies follow at a distance of 400 or 500 meters. The battalions will now continue to advance straight towards the objective, the subsequent proceedings being the same as those laid down for the company.

The chief of battalion takes post at a point from which he can best observe and keep in communication with the chiefs of companies by orderlies; he will have control of everything; he will preserve concerted action and unbroken connection, but will permit independent action if by this means the general results can be furthered.

Mounted officers will dismount when the scouts are sent forward.

The remaining portions of the official instructions received no material change.

PROFESSIONAL NOTES.

THE FLETCHER RAPID-FIRE BREECH MECHANISM.

Lieut. F. F. Fletcher, U. S. Navy, has invented a breech mechanism for rapid-fire guns that will soon be tested at Indian Head. One has been completed at the Washington Gun Factory and fitted to a 6-inch 40-caliber gun. It has already passed a series of preliminary firings with marked success, but the official trial will probably be postponed until the completion of the special mount designed for the rapid-fire 40-caliber guns.

The special features embraced in this design are the limited number of manufactured parts, the interchangeable percussion and electric firing cases and the powerful extraction and ejection.

The breech-plug is cut with six equal sectors of interrupted screw threads, and is supported by a heavy steel ring, the outside periphery of which is slightly tapered, and fits in a corresponding recess cut in the gun. This ring is locked in the gun by means of an automatic locking pin located in the ring on top.

This ring or collar is hinged on the right of the gun. The plug has cut on its rear circumference a series of spiral threads. It has also a longitudinal slot in which the lower end of the locking pin travels.

The lever is pivoted on the hinge bolt. Two sets of teeth are cut on the toothed arc, whereby the plug receives its longitudinal and circular motion. One set of teeth engage the spiral threads, the other engage the plug threads. It will thus be clearly seen that one continuous motion of the lever from left to right unlocks, withdraws, and swings the plug to the right. To close the breech, it is only necessary to swing the lever from right to left. The action is direct, without intermediate gearing.

The extractor is a thick piece of steel, the toes of which rest under the rim of the cartridge-case, and the other end against a cam worked on the back edge of the lever. The curve is of such a shape that, until the case is withdrawn ¼ inch, the speed of extraction is exceedingly slow; from this point, however, the speed is greatly increased, caused by the tail of the extractor sliding down the cam on the lever as the latter is swung back. This use of the cam surface gives almost unlimited power to start the empty case.

The firing mechanism, whether percussion or electric, is contained in a case which is quickly and easily put in place or removed, so that the change from one method of firing to another can be readily accomplished, and injury or failure of any part can be remedied by the insertion of a spare case without materially slackening the rapidity of fire.

An extremely simple safety catch is fitted under the head of the firing-pin, which prevents its premature release.

The mechanism comprises only 14 separate parts and three screws. There are no springs. All the working parts are protected, being in the body of the gun.

A. G.

THE HALPINE DIRIGIBLE TORPEDO.*

By Lieut. Cyrus S. Radford, U. S. M. C.

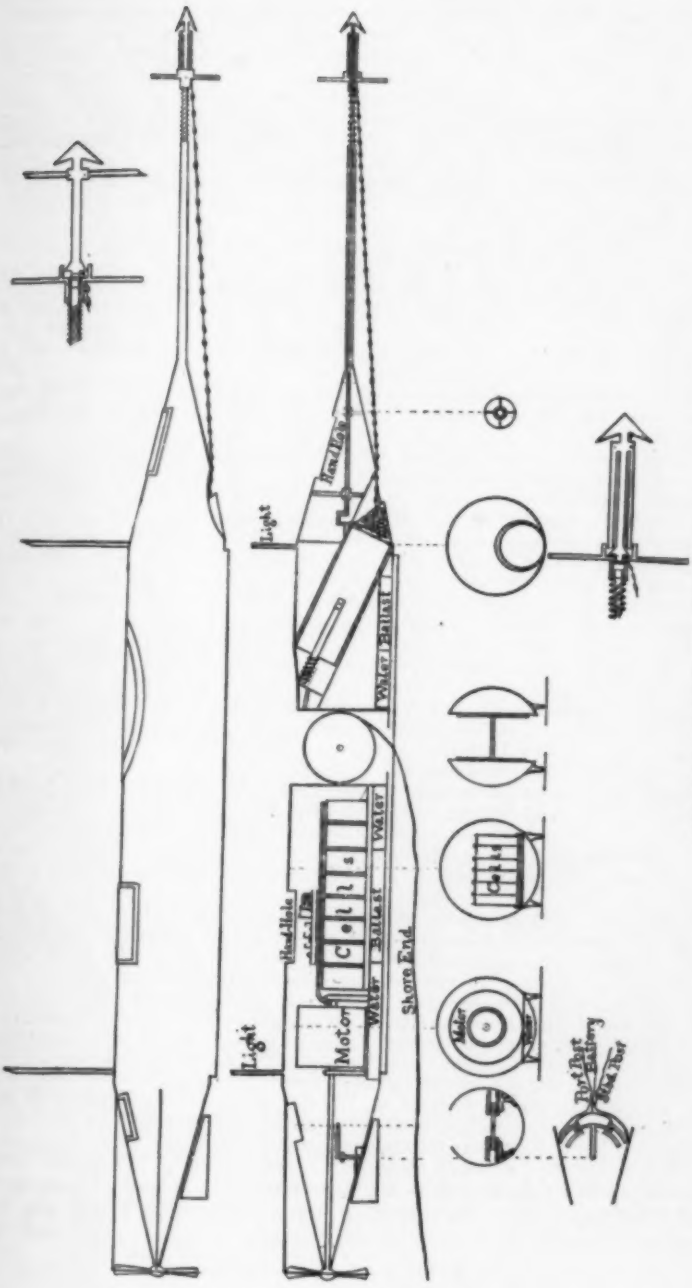
This torpedo is in reality a hybrid between a torpedo proper and a torpedo-boat. In fact it may be regarded in the latter light, as it is but a boat carrying and discharging an explosive cartridge. It is cigar-shaped, of steel or galvanized iron, 17 feet long, 2 feet in diameter, and weighs complete 1500 lbs. Its motive power is stored electricity, consisting of storage batteries of the commercial type; and from these is obtained the power, which, by means of a series wound four-pole Storsy motor, lightened of absolutely all unnecessary weight, drives the screw propeller, which is of brass, one foot in diameter, 14-inch pitch, and is protected by a circular metallic guard. The motor can impart a speed of 16 knots per hour. Beneath the body of the torpedo and near the stern is a balanced rudder, which is operated as follows: On the end of the tiller is fitted a curved bar of steel, on either side of which is a curved solonoid, which when electrified draws the helm to port or starboard as desired by attracting the curved yoke in its magnetic field. The rudder is so shaped that when the electrical influence is broken at the switch-board, the helm returns at once amidships.

Within the forward central part of the torpedo proper is fitted a reel which is introduced and removed through a hand-hole in the side. On it is coiled a fine three-stranded insulated wire $\frac{5}{64}$ inch exterior diameter, and weighing 47 lbs. to the mile, one end of the wire passing out through a watertight aperture to the operator; the other end leads to the switch-board within the torpedo. The reel has a wire carrying capacity of four miles.

The electrical controlling mechanism consists of duplicate switch-boards, one within the torpedo, and the other in the hands of the operator. It is compact, simple, and absolutely accurate. A detailed description is witheld on account of pending patents.

Forward of the reel compartment, and traversing the body obliquely downward to the front, is the discharge tube, in which the explosive charge is placed, securely sealed within its own case. The charge case is made of copper, cylindrical in shape, and has a carrying capacity of 4000 cubic inches. When seated in tube, its rear end fits over a rocket case, the outer end of which is surrounded by a spiral spring which is now compressed, and when free to act, forces the charge clear of its seat, at the same time tearing off a leaden patch from the end of the projecting rocket case, exposing a coating of metallic potassium to the action of the water. The potassium mixture is instantly ignited, and burning rapidly, in turn ignites the rocket composition, producing a propelling force that drives the explosive charge forward and downward with considerable momentum and directive force. In the conical head of the case is stored a few feet of a slack chain, one end of which is here secure, the other being made fast to the harpoon head. Besides the explosive charge, the case contains the firing device, consisting of a contact, time and electric fuze. The charge is held in place by a catch, which is released automatically by a rod being forced aft when the torpedo strikes a net, ship or other under-water obstruction; or, at the will of the operator, the catch is drawn down by electro magnets. The catch, besides holding the case in place, when tripped, reverses the motor and backs the torpedo. Rigidly secured to the forward conical end of the torpedo is a hollow cylindrical tube four feet in length, forming a protecting shell for the rod which performs the double function of tripping rod and harpoon spindle. A collar carrying four cross arms is attached to this permanent rod by means of a soft copper wire. The actual harpoon head is attached to this collar by a similar wire. The action is as follows: The harpoon point having entered the net ring, the four

*This was secretly installed on the Brazilian cruiser Nictheroy, and it has been commended by her officers.



THE HALPINE DIRIGIBLE TORPEDO.

cross arms bring up against the net; the small wire offering some resistance pushes back the rod that trips the charge catch.

This wire is sheared off, when the rod brings up, and the collar slides along the rod against the heavy spring. This brings the rear end of the harpoon head against the rod which not only shears off the (soft copper) wire that connects collar and rear end of harpoon, but releases the harpoon toggling arms, which spring open, and toggles the net between the collar and toggling arms.

The motor being now reversed, the cartridge discharged, the collar slips off the permanent rod, and the torpedo backs off leaving the harpoon toggled, with the charge free to act.

To the upper ends of the guide or steering arms (for surface work) are secured double bulb steering lights for night operations.

This torpedo being designed to run almost submerged, the possibility of striking so small an object with anything but Gatling and small-arm fire is practically nothing, and being fitted with a light steel hood over the vital part so flattens the angle of impact that the possibility of penetration seems very small.

The angle at which the charge is at present secured places it upon discharge ten feet below the harpoon head or point of impact, which is five feet below the armor shell.

Should it be desired to explode at a greater depth, say twenty feet, a float is used, fitted with arms ten feet long, the lower ends of which are strapped around the forward and after ends of the cylindrical portion of the torpedo, and the water compartments are filled to take away the torpedo buoyancy, and transfer a portion of the weight to the float, which travels on the surface.

From the extreme ends of the torpedo, curved upward to the float, and secured to a circular steel guard over the float, are steel arms kept in place by heavy springs which take the first shock on striking outer boom protection. These arms are so constructed that they slide into each other under pressure, and return to their former position when the pressure is removed.

The float is of such shape and buoyancy that it will lift lighter spars and steel hawsers, and, being forced down under heavier one, bring the torpedo at once to its original depth as soon as the obstruction is passed. The float is filled with cellulose, so that in the event of being penetrated, it will still retain its buoyancy. When this device is employed, the electrical guide lights are carried underneath the steel guard.

The proper depth of immersion is given this torpedo by letting in or forcing water out of the water ballast compartments.

. These compartments are separated by bulkheads, so arranged that the water passes gradually from one compartment to another, and is not permitted to rush forward or aft, which would tend to unsteady its otherwise very stable action.

The torpedo being launched is at once under electrical control, and is directed by the operator, who with a glass watches its guide discs in the day or the guide lights at night until it strikes the net. The harpoon head being very small there is every chance that it will enter one of the net rings. This brings the net against the four cross arms, and forcing them back, brings the tripping rod and fixed rod of harpoon in contact, which drives the harpoon arms through the ring, permitting them to open, and thereby securely toggling the net. At the same time the explosive charge catch is tripped, the cartridge discharged, the motor reversed, and the torpedo now backs off, while the harpoon being toggled in the net is no longer attached to the torpedo, and the charge being secured at the forward end by the chain continues on beyond the vertical plane of the net until the chain is all paid out, when it is forced upward under the vessel's bottom, the charge being exploded at will by contact or at a given time. The torpedo having gone astern sufficiently is once again started ahead and steered back to its starting

point, where a new harpoon and charge is provided. By giving the tube a proper inclination the explosive can be thrown over the torpedo-net against a vessel's side or directly upon her deck.

To attack a vessel without net protection, either at anchor or under way, the difference is essentially in setting the time fuze, which, as shown by absolute experiments, can be adjusted at any time from 6 to 40 seconds:

Considering the vessel to be underway, and unsheathed, the torpedo is guided to strike her well forward, the explosive charge being liberated by the harpoon head forcing back the tripping rod, and the time fuze set to allow the vessel to present her square bottom, where there can be no possible protection over the explosive point. To have a torpedo explode in contact with a ship's bow could do little more than to take out the head booms or fill the forward collision compartments, while by permitting her to pass over half her length, or about two hundred feet beyond the point of detaching, the explosive charge is presented for action at the bottom of the ship in the vicinity of her boilers and engines.

If the attacked vessel be anchored in a tideway, the charge must drift down with the tide, and the long fuze would thus be necessary, while to attack with no tide the vital point must be sought directly, and a short time or contact fuze employed.

If the vessel be sheathed, as is now the common practice with battleships and cruisers in all countries except our own, the torpedo is guided to the point of attack; the momentum of the torpedo drives the steel harpoon head into the sheathing, at the same time liberating the explosive charge and producing the same action of backing as previously demonstrated.

The electrical connections of this torpedo being so arranged that the charge may be liberated and the motor reversed at any time at the will of the operator, it would seem that its field of usefulness is not restricted solely to the destruction of vessels, but it is especially adapted for countermining and clearing a channel protected with planted mines, which is desired as an entrance for a man-of-war. Two of these weapons being sent in advance of a vessel by projecting and exploding charges could readily destroy all sunken mines within a known radius.

This torpedo can be loaded with the facility of a breech-loading rifle. Should it be captured the operator can make it destroy itself by exploding the charge within it.

The expense of the shell, including reduced charge, being eight or ten dollars, and the boat itself not being demolished, it can be sent out as often as is desired, and valuable data obtained of the effectiveness of all classes of torpedoes.

A point which must not be overlooked is the simplicity of construction; and the facility and expediency with which any number of these torpedoes can be constructed within a very short time. It is essentially a commercial type of weapon, any and all of its parts being readily obtainable from first-class firms. The hull being of No. 12 gauge steel or galvanized iron, and consisting of a cylinder and two conical ends, the forward end being riveted on, and the after one held in place by four set-screws against a rubber washer, may be obtained complete from almost any boiler shop, or worker of galvanized iron. The motor and batteries are of the standard pattern, readily obtainable in open market, and the cable and switch-boards can be had at small expense.

SHAM BATTLE BY TWO DIVISIONS OF THE CHILIAN SQUADRON.*

[*Boletin del Centro Naval.*]

The exercises and manœuvres of the squadron, which wintered in Caldera, ended by a sham attack of torpedo-boats on the port of Caldera, during the

* Translated by Lieut. S. L. Graham, U. S. Navy.

22d and 23d of August, 1893, in accordance with the order issued on the 19th, as follows:

Exercises during the nights of Tuesday and Wednesday.—The enemy's flotilla will be composed of the Esmeralda (cruiser), Condell (torpedo-gunboat), Sargento Aldea (torpedo-boat), the launch of the Esmeralda, that of the Pinto, and the two of the Capitan Prat.

The defending flotilla, of the ironclads Prat and Cochrane, cruiser Presidente Pinto, torpedo-gunboat Almirante Linch, gunboat Lantaro, and torpedo-boats of the second class, viz.: launch of the Cochrane, a boat of the Prat, another of the Cochrane, and a third of the Pinto. Night picket-boats will be armed with a gun or a machine gun.

Armament of the torpedo-boats.—They will be considered as being armed with a rapid-fire gun of 1 to 3 lbs. and a machine gun; those of the second class with a machine gun only.

Complement of torpedoes.—The launches similar to the Sargento Aldea will have four charged torpedoes and two in reserve, besides a spar-torpedo aft. Those of the defense will have only spar-torpedoes.

Days and hours of attack.—Tuesday and Wednesday from 8 P. M. to 7 A. M.

Ports; of the assailing flotilla,—English Harbor (fortified); *of the defending flotilla,*—Caldera, between Punta del Faro and Punta San Francisco (fortified).

The part comprised between English Harbor and Punta del Faro and Punta San Francisco will be considered as belonging to a neutral nation.

General Rules.—1. A vessel will be considered out of action if a torpedo-boat succeeds in approaching her within two cables (400 metres) without being fired upon.

2. A vessel with a net will be considered out of action if two torpedo-boats succeed in approaching her at the same time, under the circumstances mentioned in Rule 1.

3. A torpedo-boat will be considered out of action if she is fired upon from a distance of seven cables (1400 metres) with a 3 or 6-lb. R. F. G. or Hotchkiss R. C. during an interval of three minutes, and by four or more guns during one minute.

4. When a vessel is attacked simultaneously by several torpedo-boats, this interval will be increased one minute.

5. The torpedo-boats that have fired the torpedoes that they carry in their tubes must retire out of the port to recharge them with the spare torpedoes; this operation will not be supposed to take more than half an hour.

6. A torpedo-boat will be considered out of action if when moving she is attacked by two others acting in concert; or, when anchored, is attacked by another moving.

7. In order that a torpedo-boat may be considered to have passed a line of obstructions, it is necessary that it may have been at least two minutes in the operation of breaking it without being put out of action according to the preceding rules. If the defense has mines, ten minutes will be considered necessary to destroy or raise them.

8. If several torpedo-boats in line ahead attack an obstruction, the leading boat will be considered destroyed if they are surprised before destroying the obstruction.

9. For the purposes of this exercise it will be permitted each launch of the attacking flotilla which may have been put out of action, to return to the attack, but with the condition that it has remained half an hour outside of the line agreed upon, between Punta del Faro and Punta San Francisco.

Commanders of the attacking flotilla, as well as those of the defense, are authorized to employ every means in their power leading to the success of the attack or defense of their vessels.

If the torpedo-boats should be pursued by superior forces, they can only consider themselves safe when they find themselves within the range of the guns of the Esmeralda or Condell, if these at the time are superior to the pursuers.

In this exercise no other than 3 or 6-pdr. guns will be fired from the vessels; the fire of the great guns will be imitated with the sub-caliber tubes or with a rifle.

The obstructions will not be supposed to have been broken by the assailants.

Each launch that believes itself to be in a situation to fire a torpedo must burn a Bengal light to indicate it.

Each vessel that believes that it has placed a torpedo-boat out of action will indicate it by making the "Imperatur," and the number that the boat must carry (painted on both sides in large figures).

Each vessel or boat that is put out of action by virtue of the preceding rules will hoist a white lantern at the top.

On the morning of the 21st, at 8 A. M., the enemy's flotilla weighed anchor. At 10 A. M. they anchored in English Bay, the point fixed upon as the base of operations, preparing themselves for the proposed attack against the division which remained in Caldera. They disguised the launches, and the Esmeralda and Condell, exercising also in the tactics of Admiral Paget.

At 12 M. of the same day, the commander-in-chief of the naval division communicated to the commanders of the vessels anchored in Caldera the declaration of war, and that a fleet of torpedo-boats had set out to attack the port and would probably arrive on the evening of the 22d.

The commander charged with the defense issued the following instructions:

Instructions for the defense.—The Linch, from 8 A. M. of the 22d, will remain with fires lighted, and ready to go out on any duty that may be ordered. During the day she will remain anchored in the space which remains open between the booms of the Prat and Cochrane. During the night she will remain anchored with a kedge off Punta San Francisco, as near the shore as possible, in order that the enemy may not discover her. As soon as she discovers an attack she will give opportune notice with the signals indicated in the plan of defense herewith enclosed.

When the commander of the Linch deems it necessary, he will raise the kedge by hand, and will go to reconnoitre the enemy, showing their position by means of his search-lights.

In order to distinguish the Linch from the Condell he will cover the yellow paint of the side with canvas; at dark on Tuesday will paint his forward smoke-stack black, and at dark on Wednesday will paint both of them black.

In case of being attacked by superior forces, he will retreat to the line of defense, showing on his way the regulation lights of a steamer.

The Prat and Cochrane will anchor as near shore as possible, establishing obstructions for their defense at a distance of not less than 500 metres.

The Pinto will change her anchorage, placing herself within the lines of defensive mines, taking such other means as her commander judges proper for his better security.

He will keep his dynamo running, in order to use his search-lights during the night.

The little steamer Lantaro, from 7 P. M. until 7 A. M. of the 22d and 23d, will picket the coast on the side of the lighthouse, not leaving it at a greater distance than 300 metres. She will go with the armament that is best suited for the duty on which she will be employed.

The steam launch of the Cochrane, also armed, will anchor in front of the north fort, distant from it not more than 200 metres.

The sailing launch of the Pinto, gun mounted, will picket in front of the south fort, not leaving the shore distant more than 100 metres.

The Linch, in case of retreating, will take position without anchoring between the Prat and Cochrane, impeding the entrance of any torpedo-boats between the booms and trying not to get in the line of fire of the ships. Each picket torpedo-boat on night duty will have an officer and two petty officers of well-known competency to relieve each other on watch. Each torpedo

picket-boat that may be surprised and can not retreat will be beached, the crew taking refuge in the forts or nearest place on land. The Lantaro, upon retreating, will take position between the south fort and the sailing launch of the Prat, returning to her picket post at once if the enemy should retire. The south fort will be manned by men from the Prat, and the north fort from the Cochrane. Each of them will have a R. F. and a machine gun.

The firing of guns and machine guns will simulate that of rifles or small-arms.

Vessels will not turn on their search-lights, except when the commanders think it necessary to examine the horizon, or during an attack. For this service the bay will be divided into three sectors in conformity to that indicated in the plan of defense.

Armed boats will be placed within the booms to prevent the enemy from breaking them.

While the division anchored in Caldera prepared the defense in the form ordered, and as indicated in the plan, the commander-in-chief of the enemy's division prepared his attack according to the following programme:

Programme of attack on the squadron anchored in Caldera.—As it is supposed that the squadron to be attacked will be defended by booms, nets, search-lights, and the north and south forts, the attack will proceed with the greatest care; the commander of each torpedo-boat will prepare it beforehand, making it as invisible as possible, and disguising it in such a manner that the enemy in waiting, both by land and sea, cannot discover it. The success of the attack depends entirely on a surprise, it being well known that the enemy is powerful and relies on means that make the work very difficult.

All the rules established by the order of the 19th will be strictly obeyed.

The squadron will move at 8 P. M., the Esmeralda remaining at anchor ready to go out at a moment's notice to assist in any engagement; the crew will be distributed as is deemed most convenient by her commander. In the attack the Condell will protect the other boats in case they are pursued. At the hour indicated (8 P. M.) she will proceed directly west, and describing a large circle, so as not to be seen, will present herself at the mouth of the port, the lighthouse bearing SSE., distant 3 or 4 miles.

The remainder of the torpedo-boats will divide into two divisions: One composed of the Sargento Aldea, the launch of the Esmeralda, the launch of the Pinto; the other division composed of the two launches of the Capitan Prat.

All will be under my command as far as Calderilla, which will serve as a base of operations, and where I will await the opportune moment to approach the enemy.

The attacking divisions will enter into action at the time the chief thinks it best.

The first will operate on the north side, and the other on the south side, endeavoring not to be seen, entering close to the shore. They will tow in two boats of the Esmeralda, disguising them with smoke-stacks of canvas, to anchor in the middle of the bay, with the object of representing steam launches, and that the enemy will converge their lights and fire upon these points. In case this should occur, it will be the opportune moment for the divisions to approach the shore and move in.

In any case the object of the expedition will be that of placing the boats so as to discharge a torpedo at any of the enemy's vessels without being discovered, lighting a Bengal light when at that distance.

It is resolved to try to refuse an engagement, and to protect yourself on the shore side, in case that the lights illuminate them, and that the fire may be concentrated on one torpedo-boat. The Condell will be ready to protect with her battery and torpedoes any launch that may come out pursued by the vessels or picket-boats of the defense.

In case of a repulse the flotilla will enter Calderilla, which will be the point of rendezvous for repairing damages.

It is supposed that a flotilla of torpedo-boats composed of five launches, of the type of the Sargento Aldea, can defend themselves during a night in the anchorage of Calderilla, and successfully repulse any attack of cruisers and torpedo-boats of the type of the Linch that endeavor to enter to destroy them.

In the case of a defeat, repair damages, organize the remainder of the expedition and repair to English Harbor, which is supposed to be the center of operations.

To avoid confusion during the night and to recognize each other, the following plan of signals, with Bengal lights, will be observed between the launches, never displaying a light inside of the port, using as a countersign one green light and as a signal another green light. By voice the countersign and signal will be *Cochrane* and *Pinto*. The attacking party will try and make it effective; after having overcome the first difficulties they will advance in line ahead. In case of damages the assailants will try to protect each other and tow the damaged ones outside, if it is possible.

The launches that compose the two divisions will try to keep within hail of each other.

The Condell will picket outside of Caldera until daybreak, keeping always under sufficient pressure to escape the pursuit of a cruiser. In case of being attacked by the Linch, she will not engage within nor in front of the port, but will try to make that vessel pursue her to the southward.

When a launch is in danger of being captured it will fire a red Very rocket, as a signal of distress, indicating that it requires assistance. When two Very rockets are fired, one of red and the second green, it will mean an assembly of the launches.

After daybreak the Condell will return to the anchorage of the Esmeralda.

Paymaster Necochea will act as aid to the chief to take notes upon the different operations that are made. On Wednesday, August 23d, the following supplementary orders were issued, as follows:

As supplementary to the order of yesterday the following will be added regarding the attack which will be made to-night.

1. The Esmeralda and Condell will carry at the foremast head the national flag as a distinguishing mark.

2. In order to recognize each other, each one of the boats will make its "absolute" with the whistle, except the boats that operate within the bay, which will not do it, so as to prevent being surprised.

The divisions will use the system of signals used last night in Calderilla.

In the attack the commanders of divisions will bear in mind the propriety of seizing any boat that is not in the mouth of the port, as this will decrease the enemy's picket. The Sargento Aldea will take charge of the placing and anchoring the boats, imitating steam launches in the place that is most convenient, in the middle of the bay, lying in wait afterwards for the boats that may come to capture them, or better to enter the port, if perchance the search-lights of the enemy are converged upon the disguised launches. The chief of the second division will at that time take charge of carrying out the second part of the programme assigned to the first division.

It is again urged upon the commanders of launches that they will carry out strictly the orders of the 19th, referring to the established rules of the attack and defense. The flotilla will weigh anchor at 8 P. M. All the launches will be towed by the Esmeralda. At daybreak the flotilla will assemble about the latter vessel 4 or 5 miles northwest of the light-house.

(Signed) V. M. Donoso.

Reconnoissance and attacks.—In order to follow the different operations of the attacks by the enemy's divisions we have thought it best to give the reports of Commander Donoso and that of the commander of the Sargento Aldea upon their operations during the nights of the 22d and 23d of August.

ON BOARD, CALDERA, *August* 26, 1893.

In compliance with my duty and the order of the 24th, I have the honor to report to your lordship upon the operations made under my command against Caldera during the nights of the 22d and 23d inst. In conformity with the order of the 19th, on Monday, the 21st, I went to sea with the flotilla assigned to make the attack. On account of the slow speed of the launches we could only make between 4 and 5 knots speed, leaving at 8 A. M. and arriving at English Bay at 10 A. M., where we anchored. The remainder of the day the crews were occupied in getting ready for the attack, which was to be made during the nights of Tuesday and Wednesday, disguising steam launches and preparing boats to imitate steam launches with smoke-stacks.

Besides this, I was employed with the Aldea in anchoring buoys for the Esmeralda and Condell to exercise in the tactics of Admiral Paget.

During the night the order made by me was followed out, a copy of which I have the honor to append, as well as the orders of the 22d and 23d.

On the 22d the work of disguising the launches was continued. At 6 P. M. I went out in the Condell to reconnoitre Caldera, with good results, not being seen. We could observe the change of anchorage that each one of the enemy's vessels had made.

With these antecedents, at 8.30 P. M., the Aldea towing the disguised launches left the bay, the steam launches of the vessels formed in two divisions, in line ahead to port and starboard of the Aldea; off Calderilla it blew strong from the southwest; therefore, in accordance with orders and fearful of damage or accident to the launches, I determined to leave these in Calderilla. After putting ashore a machinist, with orders to cut the telephone line from the lookout station at the lighthouse, a picket service was established about the entrance of Calderilla to prevent a surprise by the enemy. This being done, I went out with the Aldea to make a short reconnoissance of Caldera; it happened that I was not discovered. I pretended to attack on the north side, approaching so near the Linch that with the naked eye I made out her masts and hull, which caused me to advance nearer, so that I made out a great deal of smoke escaping from her smoke-stacks. At this moment a tube broke in the Aldea, which made many sparks, and a great deal of steam escaped from her smoke-stacks, in consequence of which the enemy was alarmed. This accident obliged me to run out at full speed to prevent being fired upon. Fortunately, after the first alarm the search-lights could not locate me.

The sea continued pretty rough, and the Aldea was in a very bad condition for a surprise; therefore postponing the attack until the following night I decided to return to Calderilla, in search of the launches and return to English Bay. On the way rays of an electric light and green lights were seen to the southward. This led me to suppose that the Condell had made the Linch pursue her to the southward, and in the offing at English Bay the Linch would engage the Esmeralda as at the same time cannonading was heard.

At 12.45 A. M. the Aldea anchored with all of the launches in English Bay, where I found the Esmeralda, which had heard the firing and was ready to go out. Under these circumstances I left the Aldea to be repaired, and made the other launches anchor, except the Vedette, which I ordered to make another reconnoissance of Caldera and at the same time to find the Condell.

I went out in the Esmeralda with the same object in view, and at dawn (4.30 A. M.) I met the Condell, and from their report I was convinced that she had not had any engagement. At 5.15 A. M. the Vedette came on the starboard side of the Esmeralda, the commander reporting that, without being seen, he had placed himself within 400 metres of the Capitan Prat, which he had torpedoed.

As nothing more could be done this night, at 6 A. M. we anchored in English Bay.

Wednesday we worked on the Aldea to have her ready. Evolutions could not be made by the Esmeralda, as the buoys anchored for that purpose had gone adrift.

At 8.20 P. M. the Esmeralda went out from English Bay towing the Aldea, the rest of the launches in two divisions. At 9.30 P. M., in the offing south of the lighthouse, the Esmeralda stopped and cast off the tow. At 10 P. M. the Vedette was ordered to make a reconnoissance of the port, and at 10.10 P. M. the Aldea was ordered on the same duty with the order that if she saw the Condell to send her to the Esmeralda for new instructions. The launches of the vessels picketed on either side of the Esmeralda.

At 11.30 the Condell with the Aldea and Vedette came alongside of the Esmeralda; these with the other launches received orders to prepare for an attack which ought to be made simultaneously.

At 12 M. a number of shots were heard, occasioned, no doubt, by a false alarm, as the attacking launches could not yet have arrived.

The Esmeralda stood on and off 2 or 3 miles from the mouth of the port. Opposite the lighthouse a launch was noticed which did not give either the countersign or signal. A 6-pdr. was fired at her from the port side. This took place at 12.30 A. M.

From that time until 2 A. M., a fierce engagement was initiated between the assailants and the assailed. This cruiser during this time turned around in the entrance of the port, observing the events as they occurred, and ready to protect any boat that was pursued.

At 2.20 A. M. the steam launch of this vessel came alongside, towing one of the disguised boats, and reported that she had been surprised and sunk by the Lantaro, and while that steamer attacked her, the Condell at the same time threw herself upon the Lantaro, and it was to be presumed that the latter was put out of action or sunk.

At 3.15 A. M. the Esmeralda gave the signal for the assemblage of all friendly launches, firing an 80-pdr. and two yellow Very rockets; approaching the port as near as possible, to be seen by the boats.

The Condell, Aldea and Vedette reported to me, and received orders to be ready to enter and anchor in Caldera at 7.00 or 7.30 A. M. At this hour we anchored, finding all the other launches at anchor inside, sheltered from the strong north wind, which blew during the night.

Finally, I take pleasure in manifesting to your lordship the interest and zeal which all the officers, as well as the men have taken, who have operated under my command during the two days and nights that the exercises continued.

All have worked without rest, and to my satisfaction. God guard your lordship.

(Signed) VICTOR M. DONOSO.

CALDERA, *August* 29, 1893.

To the Commander-in-Chief of the Naval Division:

In accordance with the order of the 24th inst., I have the honor to report the part that the Sargento Aldea performed during the sham attack on the squadron anchored in Caldera.

Tuesday, 22d, at 12.30, the attacking flotilla anchored in English Bay. Two boats were sighted, hovering around the south point, one rowing and the other sailing; at the same time discovered on shore what appeared to be groups of horsemen. I received orders to make a reconnoissance and to cut off their retreat if they had advanced too far. I was not able to do this, and directed my attention to overhauling the boats, which were manned by fishermen who had left Caldera in the morning. I directed them to proceed to the Esmeralda, where information of the situation of the enemy's vessels was obtained from them.

Immediately after obtaining this information Commander Donoso embarked on the Aldea, and we set out to make a reconnoissance of Caldera, taking an outside course so as to be four or five miles from the coast; afterwards

steering to the northward, until off the lighthouse, and we could distinguish the masts of the Cochrane and Linch. We approached the coast, bow on, to the lighthouse, so as to present a small target, and observed well the positions of the vessels in the bay. After recognizing these we steamed for Calderilla, to observe if the party to be attacked had made any defense of that port. Assured that nothing existed we returned to our anchorage.

About 8 P. M., and after a consultation with Commander Donoso upon the manner in which he was going to carry out the attack, we embarked in our launches and set out for Calderilla, formed in two divisions. Upon approaching it was seen that a dispatch-boat was thrown out from the coast.

A man was ordered ashore to cut the telephonic communication from the lighthouse.

After the launches anchored we went out with the Vedette which remained outside, standing off and on, while we set out to make another reconnoissance and to return for the other launches to make an attack.

We made the same evolutions as during the day, until arriving about in front of the port, and could see the search-lights of the four vessels, which illuminated us a little, although we thought they could not see us, as they did not stop us; besides, it could be seen that the rays of the search-lights of the Prat in passing from one point to another passed very high. We started at once to northward under all steam, and arriving at a short distance from the shore we steered in towards the Linch, whose search-light remained fixed, illuminating Punta San Francisco, while the others illuminated the southern part.

When about 2000 metres from the Linch I saw a rocket discharged from the south side, and all of the search-lights, except that of the latter vessel, were directed in that direction. At this time the order was given to go ahead at full speed, steering directly towards the Linch, but owing to an unfortunate accident, on account of which the Aldea began to throw out a great deal of smoke, sparks and steam from her smoke-stacks, we were obliged to withdraw. On inquiry, I ascertained that a tube had burst, causing an escape of steam into the uptake. We took a round-about course on the return, so as not to be seen, and set out for Calderilla, in search of the other launches, hearing, a little while before arriving, several shots to the southward. Upon our arrival the launches were hoisted, and we left for English Bay. A short time before reaching that place we broke another tube, which was reported to Commander Donoso, who had remained on board all this time. About two hours after we anchored, the Esmeralda got under way. For the reasons mentioned, the Aldea could not continue the operations, drawing fires in order to make necessary repairs.

Operations on the 23d.—The boiler repaired, we went to sea about 8 P. M., after a consultation with Commander Donoso, in tow of the Esmeralda, formed in two divisions.

After a short time the tow was cast off, and we continued in this order until about 4 or 5 miles outside of the lighthouse, where I received an order to make a reconnoissance of the bay. Leaving the launches of my division, and the disguised boats alongside of the Esmeralda, I proceeded towards the north point and approached the port, observing the various positions.

As the search-lights of the Capitan Prat and Linch were directed where the Lantaro picketed, and where the Linch was anchored, I could observe with the greatest ease the positions which the enemy occupied. On arriving off the south point I met the Condell, and together we returned to the Esmeralda to report our observations. Upon arriving, the two divisions were formed by the launches, and convoyed by the Condell we proceeded to put in practice the plan of attack, of which the first part consisted in attacking, with the first division, the gunboat Lantaro.

The convoy proceeded in the following manner: The Aldea took a boat in tow, the launch of the Pinto another. The launch of the Esmeralda went in

shore and proceeded towards the bay, with orders to await me at the south point, where I had been able to observe that the Lantaro picketed. The Condell was to make a feint on the north shore while the launch of the Pinto entered to anchor the disguised launches and the rest of the first division attacked the Lantaro. When we arrived a short distance from the bay a shot was heard; separating myself from the Condell I steered for the south point, and, on arriving a little inside of the lighthouse, an alarm was given, the Lantaro firing on a launch, that I suppose to be that of the Esmeralda.

At this time I let go the boat in tow, and ordered the launch of the Pinto to take it, and went inside to the aid of the launch that was engaged with the Lantaro, which asked assistance, but finding that the Condell had come to her assistance, taking advantage of the moment, in which all the search-lights were turned on the launch of the Esmeralda, except that of the Linch, which remained fixed on Punta San Francisco, I proceeded toward the latter vessel at full speed, and succeeded in arriving 500 or 600 metres from her without being seen, and fired one of the bow torpedoes at her. At that moment the search-lights were directed towards me, and turning to port, in order to approach nearer, I discharged the other torpedo at a distance of about 200 metres, and retired at full speed.

Before firing the second torpedo, fire was opened on me, which I returned with the machine gun. As soon as I was out of the rays of the search-lights I joined the Condell, reporting to her commander what had occurred. We were outside a long time waiting an opportune moment to attack.

We reunited with the other launches, proceeded to the entrance, and waited until the Condell might reach the north side to attack, and then uniting at the south point we steered inside. When we saw that only the search-light of the Linch was burning we proceeded at full speed towards the Cochrane. Arriving at the booms of the Prat and Lantaro, the alarm was given. At once we fell off to starboard, until very close, firing two torpedoes; then proceeded toward the Cochrane. Arriving at a distance of about 400 metres from her, a launch that was astern gave the alarm, we turned toward the Linch. About 300 metres from her we took the picket-boats in the rear, one of which fired at us several times with a rifle. On passing the Linch, distant about 30 metres, they gave us a heavy fire, which we answered with the machine gun. The bow of the Linch was hardly passed when they placed their search-light on us. At the same time we were connecting the hand steering gear, the steam gear having been disarranged; we went outside and again joined the Condell, which vessel reported what had occurred; going to the Esmeralda for instructions, I received orders to wait at the south point to again attack between 4 and 5 A. M. A little time afterwards the Esmeralda made the signal for the assembly of launches; went to her and waited outside until daybreak to enter the port, where we anchored at 7.15 A. M. without anything further occurring. All of which I have the honor to submit to your lordship.

(Signed) J. SCHROEDER.

In order to judge of the efficacy of the torpedoes discharged by the enemy we give the part taken by the commander of the Linch, who by his position during those nights, has been better able to follow the movements of the enemy's torpedo-boats.

CALDERA, *August* 24, 1893.

I report to your lordship that which occurred on this vessel during the nights of the 22d and 23d insts. In accordance with the instructions of the defense at dark of the 22d, we anchored near Punta San Francisco. At 12.30 the Lantaro fired a rocket, and a launch was seen a little to the north of the lighthouse. A little after, the Condell was distinguished outside, and towards the middle of the bay, which vessel cruised all night about the port. At 1.15

a launch was surprised by the Lantaro, which fired on her ; 2.30, the Condell, having approached, was fired on ; 2.45, two launches entered the middle of the bay, fired on one that apparently came toward us, the other appeared to enter the bay. Upon clearing, saw the Condell to the northward with the Lantaro, the latter changed course to the southward and returned to her anchorage for the day. Yesterday, at 6.30 P. M., we anchored near the north fort. At 9.45 a great deal of steam was seen escaping from the launch of the Cochrane, which cruised between our vessel and Punta San Francisco, our boat was lowered to tow her, as it was seen that she used oars. Her safety valve was damaged so that she could not picket her part of the coast. 10.40 P. M., the Condell was seen coming from the north, the signals ordered were made ; as she continued to approach in spite of the fact that our signals indicated to her that she had been seen, a gun and rifle shots were fired at her. 12.15, a launch was discovered similar to the Sargento Aldea, coming from the northward ; fired upon her until she was compelled to retreat behind Punta San Francisco. At 1.00 the Condell returned in mid-bay with a launch that followed her inside. 1.30, the Sargento Aldea fired a Bengal light in the center of the bay, about 1000 metres to starboard of us, in spite of having been discovered by us in time. 1.50, a small launch was fired upon which was seen to starboard. 2.15, the Sargento Aldea was discovered in the center of the bay. She was fired upon; in spite of this she concentered her course inside and fired a Bengal light about 1000 metres from the Prat. 2.30, the flagship made signals which could not be understood, as the plan of night signals had been communicated to the Condell, and by which supposed they were to suspend the exercise, as she lit her side lights at the same time. During the two nights the enemy's launches have not been able to enter either from the northward or southward without being seen; they have only been able to do so in the middle of the bay, which was not picketed. God guard your lordship.

(Signed) F. GONSALEZ.

Criticism.—In the opinion of the arbitrator for the defense, it worked under many difficulties ; considered individually, each vessel was efficient, but as a whole it offered many feeble points. It would have been better, instead of making three booms, to have made only one, with the means at the disposal of all, extending it from the south to the north forts, anchoring the vessels 500 metres in rear of this line, arranged to employ the greatest possible fire against the enemy, with the launches and armed boats placed within in such a form that any attack would have been impossible. The forts would have defended the feeble and most exposed points to be attacked.

The situation of the Linch was so critical that if the enemy had had better means at his disposal that vessel would have been captured. It is necessary to remember that the defense could not interrupt the regular traffic of the bay by the regular passenger steamers. In case of actual war the defense would have had at hand all the disposable means in the port, which they did not have at this time. They had insufficient means, as some open places were left, between which torpedo-boats would have been able to slip and carry their attack to the stern of the vessels, a part feebly defended and not guarded as well as the bay ahead of the vessels.

The duties of lookouts and pickets was well carried out; the presence of the enemy's vessels before the entrance of the port was given opportunely.

The service of the search-lights left much to be desired in the first attack, improving in the second, in that they regulated themselves suitably.

It has been shown that the lower search-lights do not permit good observations of threatened points; the observer placed immediately behind the projector, is deafened with the crackling caused by the electric current and is blinded by the light in such a manner as not to be able to follow a discovered launch or hear the directions of the commander or officer who observes the horizon.

It is necessary to place the man who manages the projector some distance away entirely in the dark.

The top-projectors of the Prat performed their service perfectly, and managed from below, one could observe and explore without the inconveniences of the bridge-projectors.

We think that the attack projected by the commander of the enemy's division was carried out with intelligence, but it failed of success for various causes.

Respecting the launches and their fittings, only two could be considered fit for a surprise attack, the Sargento Aldea and the Vedette; the first was disabled the first night. The other launches, in spite of being disguised, could not hide their presence on account of the nature of their engines.

In the two nights the rough sea made the management of these boats very difficult. The clearness of the night deprived the attack of many of the advantages necessary to a surprise. On the other hand, the defense arranged enough search-lights to have the narrow mouth of the port constantly illuminated.

The commanding officers of the Sargento Aldea and Vedette claim to have proved that they discharged their torpedoes at a proper distance. Disturbed by the lights and deceived by the great hulls of the anchored vessels they could not judge the distance. From within, from the shadow, it was judged that those distances were greater than those agreed upon to consider a discharged torpedo effective. The Vedette, which claims having arrived as far as the booms of the Prat, had been fired upon by the Cochrane, and could be considered as sunk.

The Sargento Aldea, after firing a torpedo from a great distance, was followed by the guns of the Prat, Cochrane and Linch; she ought to be considered damaged. The Vedette, when damaged, granting that she had been able to reach the booms of the Prat, her torpedo discharged at a greater distance than 500 metres would have been entangled in the net. Another launch was captured by the Lantaro. It is not accepted that the Condell from a distance of 2000 metres would have been able to sink the Lantaro during this capture.

In these exercises, carried out for the first time by the vessels of the squadron, there will be much to criticise, but it is just to say that there has been much to praise and encourage.

A desire to excel in what each one had undertaken has been manifested. Chiefs, officers and men have stood at their posts during the successive nights, encouraged by desire to contribute to the success of these manœuvres. There have not been wanting original stratagems, and means employed for the first time in the use of signals. The experience acquired on this occasion will be profitable for future exercises which, we hope, will be repeated with more frequency, especially when a squadron of evolution is formed.

(Signed) P. N. M. E.

BACK FIRES THROUGH PRIMERS IN CARTRIDGE CASES.

By Mr. E. G. Parkhurst.*

It is a fact well known among ordnance officers that back fires, commonly termed blow-backs, through primers in metallic ammunition, many times cause serious accidents, clogging the breech and breaking or disabling the firing mechanism, the damage done being about proportional to the chamber pressure in the gun. This is usually attributed to imperfect or defective primers which are pierced by the point of the firing pin. The

* Pratt & Whitney Co., Hartford.

question is, are they pierced before or after the explosion of the powder in the cartridge case?

A firing pin weighing 1½ oz. driven by a 16-lb. spring has done equally effective work on the same primer cap (thickness .06″) with a 3¾-lb. hammer under the pressure of a 112-lb. spring. The projection of the point through the recoil plate 0.10″ for the heavy blow, and 0.70″ for the light. We would advance the theory that the forward stroke of the pin under the spring pressure partially perforates the cap and that the explosion completes the work already begun, and if the firing point is held lightly in place, there will be much less liability of a primer being pierced. This theory has been in a measure proven by an interesting experiment lately tried under the auspices of a well-known naval ordnance expert on the primers for firing the 3″ gun. The before-mentioned officer had prepared 5 rounds with defective primers, made so by reducing the thickness of the cap 66⅔ per cent., or from .06″ to .02″. In all previous experiments the weakening of the caps had produced the desired result: they were blown through. The five were fired, and to the astonishment of all concerned there were no back fires. The weight of main spring used was 20 lbs. and the firing pin 2 oz. Close examination showed the indent well rounded in and somewhat larger at the outside than the aperture in the recoil plate. The other rounds, nineteen, fired with regular primers, showed well set back, with the exception of the first fired, half charged.

THE NAVAL MEDICAL OFFICER, AND EXPEDITIONARY BOAT DUTY.

[*Extract.*]

By John C. Wise, M. D., Surgeon U. S. N.

While it is not probable that boat operations will play as important a part in the maritime warfare of the future as they have in the past, the recent troubles in China and Hawaii demonstrated the need of methodical consideration of this subject.

There has been in our past history a singular apathy in providing surgical aid to those engaged in this duty, and this is the more remarkable when we consider how sanguinary these contests have been.

During the Revolutionary War, flotillas, offensive and defensive, swarmed the inland waters. In an engagement in the Chesapeake, known as "The Battle of the Barges" (occurring in 1782), by an explosion of an ammunition chest on the Virginian barge Protector, twenty-nine men, including the officers, were wounded, and an equal number killed; yet there was no surgical aid at hand, and many deaths occurred from hemorrhage. In 1812 there was a semblance of organized medical and surgical aid. During the Civil War, boat operations, though numerous, were not so disastrous to life as in previous conflicts.

Just what elements of warfare modern improvements will eliminate is uncertain, but at this time, on foreign stations, boat expeditions as patrols, or for the purpose of defending life and property, are not uncommon.

The conditions under which boat expeditions are called away are numerous, and with different purposes, requiring different preparations. Often the occasion is fore-known, when the medical officer is notified and instructed; at other times the duty is emergent, and it is then that the benefit of previous consideration is apparent.

When boats are called for "landing where likely to be opposed" the question to the medical officer is largely one of transportation, and subsequent

field duty. This was a common experience in our late troubles at Honolulu, but will not be considered here.

The circumstances where boats are called most likely to concern us, are: "Cutting out," "contending with other armed boats" and "armed and equipped for distant service.

When armed boats are called away, the medical officer will muster his crew at the "hospital boat" and proceed as rapidly as possible to equip it, and report provided and ready.

The crew should wear the brassard, and carry no arms.

The medical officer will dispense with side arms. In operations where the enemy is not party to the Geneva Convention—as in China—arms are carried for self-defense. The hospital boat flies the Geneva Cross at the bow and the national ensign at the stern. The equipment other than medical is:

1st. Provisions, consisting of canned meats, bread in water-proof bag—quantity varying with probable length of expedition. Fresh water in breakers.

2d. Cooking utensils. Mess kettle, tin pots, spoons and bucket, lantern and matches.

3d. Boat gear. This should be minimized. No spars—a good tent should be substituted for sail—a small tool chest, glasses and signals.

The medical outfit is that from the supply table of the Navy and consists:

1st. Expeditionary and boat case, surgical. That issued in the new supply table is very compact and complete.

2d. Expeditionary and boat case, medical. This has also been revised and perfected, a large assortment being permissible in tablet form. These cases are fitted in leather pouches, having sling straps with buckles and snap hooks.

Medical officers will usually carry some personal equipment—a pocket case, hypodermic syringe, a few rollers and a flask of brandy; an ordinary haversack will carry them conveniently.

All officers with proper sense of responsibility will never leave the equipment of the hospital boat to the coxswain, but personally inspect everything before reporting.

The instructions require a medical box in each boat, about which the senior officer of the boat should be informed. In no service are the personal surgical equipments so important as on expeditionary boat duty. Every member of such expedition should carry a "wound package," that of Prof. Esmarch, pinned to the inner lining of the coat. This consists of a triangular bandage, two pieces of sublimate gauze, a gauze bandage four inches broad and six feet long. This wrapped in water-proof material makes a package about 4 inches square and weighing 3½ ounces. The first field dressing used in the English service is better adapted to naval use, it consists essentially of "two ounces carbolized tow, a carbolized gauze bandage, a triangular bandage for sling, the whole incased in tin foil wrapper and parchment cover" (Manual for Medical Staff Corps, 1885).

The elastic suspender of Prof. Esmarch, or that ordinarily worn, will be of service in great emergencies. Too much stress cannot be laid on instructions in first aid to all liable to be on such duty as we are considering—especially does this apply to the officer of any boat and the crew of the hospital boat. Careful instructions until proficiency is attained is most desirable.

The hospital boat represents the first line of medical aid. The base of operations may be the ship, or a "collecting station" on shore, and again, in many cases, there may be none, all aid coming from the boat alone.

The emergencies of naval operations are even greater than those attending military operations on shore. The best way to utilize his facilities the medical officer will find to vary with the situation, and possibly to depend on instructions. If not too distant, the ship should be availed of as a base, but in the majority of cases the situation will demand the presence of the medical officer, and not permit of transportation, all service being in the nature of first aid.

Boat contests are usually short and decisive, and the hospital boat, to be of most service, must remain at the scene of action. In rare instances it may become necessary to establish a "collecting station" on shore, where the tent may be pitched, to which the gravely injured may be transported and cared for.

It is not within the brief scope of this paper to discuss questions of military surgery, but reference will be made to some of the resources of paramount value in this connection.

Of hypodermic medication, Surgeon-Major Porter justly remarks, that "it has been found to afford such speedy relief, to be so convenient of administration, and so portable that it is now generally used in warfare."

Concerning first dressings, probably every surgeon has his favorite method, but all agree as to the great desiderata, simplicity and cleanliness. We have spoken of the personal equipment, and the wound package, which will be found to meet all ordinary requirements.

During the late troubles in Samoa, when the medical supplies of the U. S. S. Alliance had been almost exhausted in the aid rendered the warring factions, an oakum dressing, confined with a bandage made from the leaf of the banana palm, succeeded well with the natives. It was noticed also in this connection that seawater was used frequently and freely on recent and chronic wounds, and apparently with good results.

Slighter cases of hemorrhage are readily controlled by compress and bandage. In more serious cases, the field tourniquets of the surgical box are available, and these are also carried in each boat and can be applied by the officer in charge. Deligation of an artery should never be attempted in a boat if it can be avoided; all conditions are unfavorable, and if to these are superadded a rough sea or darkness, it is well nigh impossible.

The resuscitation of the apparently drowned, picked out of the water, and taken into a boat is best conducted after Sylvester's method,* and in the following manner: The crew is massed in the bow and stern, two bow oars only being used to keep the boat's head to wind; four oars with blades forward are laid upon the thwarts, covered and kept together with a tarpaulin; on this the patient is placed, with head aft. The medical officer and assistant to whom he assigns one arm, take position behind head of patient. If a good helmsman keep the boat well up to the wind, thus preventing rolling, this method is quite practicable. For embarking or disembarking the sick and wounded, the cot of Medical Director Gihon, U. S. Navy, is decidedly the best we have;* it has a very decided advantage over the ambulance lift of McDonald * in the fact that the vertical position permits of easy passage of a hatchway, and its motion is more easily controlled.

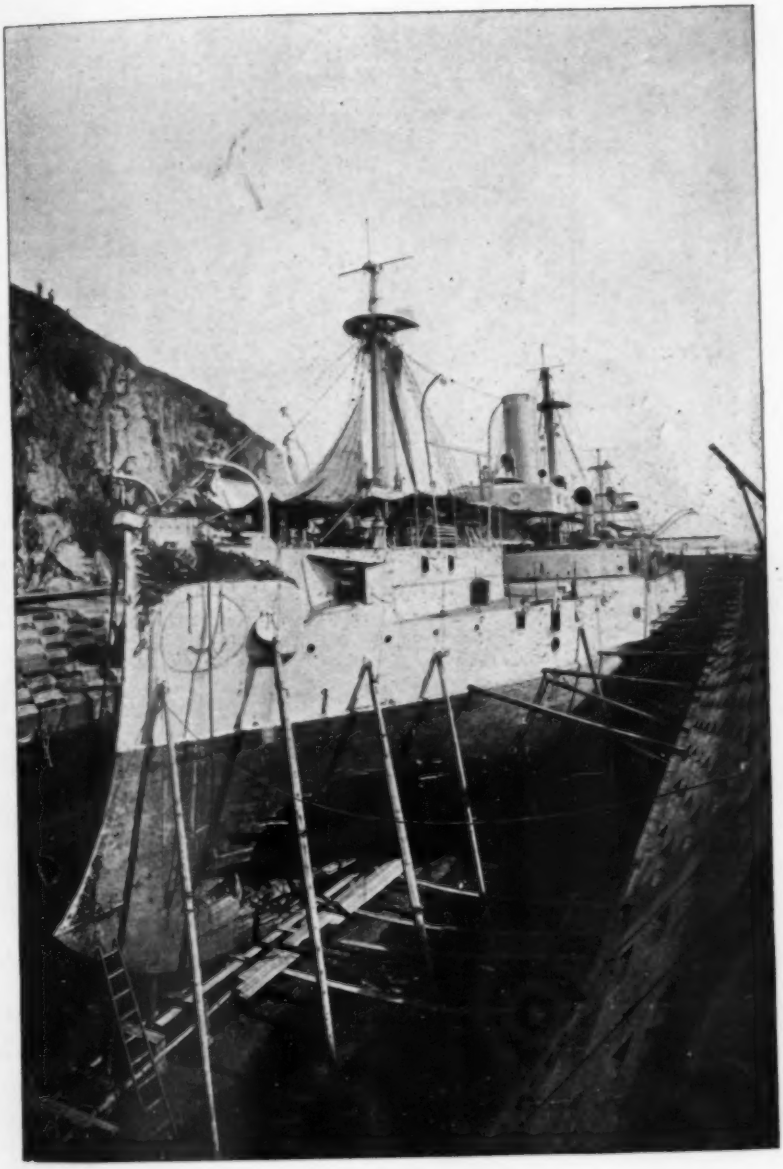
THE AQUIDABAN†.

TORPEDO EFFECT.

The accompanying photograph is of the Aquidaban in dock after having been struck by a Whitehead torpedo. The water-tight bulkhead situated at the twelfth frame from the bow, and the protective deck are intact. The ship made the passage from Desterro to Rio under her own steam and without repairs after being struck.

*See "First Aid to the Injured and Transportation of the Wounded" by Surgeon Henry G. Beyer, U. S. Navy. PROCEEDINGS U. S. NAVAL INSTITUTE, No. 63, pages 411, 427 and 429.—ED.

† The photograph and accompanying notes were kindly furnished by Henry B. Soule, Gunner U. S. Navy.



THE AQUIDABAN

The Gustavo Sampio, which did the torpedoing, is a torpedo-gunboat having a bow tube and two broadside launching tubes, two 20-pdr. R. F. G., and four 3″ rifles. She, in company with a torpedo-boat, something after the style of the Cushing, entered Desterro harbor, where the Aquidaban was at anchor, shortly after midnight, April 16th.

The torpedo-boat advanced, and at 100 meters fired her bow torpedo. At 75 meters she launched her broadside; both missed. The Sampio then advanced, and at 75 meters fired her bow torpedo, which missed, and at 50 meters her port broadside. The last torpedo struck the Aquidaban about ten feet below the water-line, and twenty-five abaft the bow, making a hole twelve feet square on the port side, and a round hole three feet in diameter on the starboard side. The plates for several feet around the port hole are crushed in. Very little pretense was made toward directing the tubes. Strings were led from the triggers of the broadside tubes to below decks, and they were fired in this way with no one on deck. The Aquidaban had machine guns at work on them before the first torpedo was launched, and search-lights on soon after.

The torpedo was set for a depth of five feet. It had been charged for several days.

THE CONSTITUTION.

It has been long thought that the Constitution should be put in order for harbor service, and used as a school-ship for naval apprentices. To accomplish this end it is only needful to work up a little popular sentiment in order to secure the necessary appropriation. In this connection, the following from the letter of "Sydney" in the *Boston Transcript* of June 9, and the article entitled "Nelson's Battleship Foudroyant, from the *London Times* of May 18, are interesting. The Victory, it may be remarked, is still in commission.

[*London Times*, May 18.]

NELSON'S BATTLESHIP FOUDROYANT.

To the Editor of the Times.

SIR:—In September and October, 1892, you opened your columns to a correspondence relating to the sale of Nelson's battleship Foudroyant, and, although time did not admit of advantage being taken of the willingness of the then Lord Mayor to open a public subscription to raise funds for her repurchase, Mr. J. R. Cobb, of Brecon, patriotically stepped forward and found the necessary money, when she was forthwith brought back to the Thames from Germany, where, however, she remained sufficiently long to enable the German Emperor to pay her a visit, and excited in him admiration at her lines of construction.

Since her return to the Thames, where she has remained under the protecting care and at the expense of Mr. Cobb, many conflicting accounts have appeared in the press concerning her fate, and it may interest your readers to learn something definite about her. It has now been determined that she shall be restored, as nearly as possible, to the same condition as when launched in 1798 to carry Nelson's flag. For this purpose the services of Mr. Farquharson (formerly of the Admiralty), who so ably designed the model Victory for the Royal Naval Exhibition, have been retained, and thanks are due to the Lords Commissioners of the Admiralty for their courtesy in lending her original plans and designs.

It is intended, as soon as the necessary work has been completed, to exhibit the ship at the principal ports of Great Britain and Ireland, and subse-

quently to sail her to the United States and the colonies, but in the first instance she will be taken to Manchester.

It may interest you to know that every timber of the ship is as sound to-day as when she was launched nearly 100 years ago.

Your obedient servant,

C. S. SHEPHERD, Secretary,

13 Carlton-chambers, 12 Regent-street, Pall-mall, S. W., May 17.

[*Boston Transcript*, June 9.]

The claim of Portsmouth, N. H., to the Constitution, which Boston wants and Washington ought to have, is an example of unblushing cheek. The old ship happened to lie at the Portsmouth yard the last time she went out of commission, and was simply allowed to remain there. When there was talk of removing her the people of Portsmouth set up a howl, just as if the Constitution belonged to them. The fact is, she is a great attraction at the Portsmouth yard, and the people are loth to give her up. The opinion among naval people is that the ship ought to be thoroughly fitted up as she was at the time of her glorious career, and kept at Washington, as a museum of naval relics. She is now nothing but a dismantled hulk, boarded up outside, bare inside, and wholly unsightly. The cost of fitting her would not be great, and perhaps the navy yards of the country might furnish enough old guns for her batteries.

NAVAL PROGRESS DURING 1893.

[*Deutsche Heeres-Zeitung.*]

Translated by LIEUT. H. G. DRESEL, U. S. Navy.

The past year has been rich in occurrences that have more than ever before brought naval matters to the foreground of public interest. The great international naval review attending the opening of the World's Fair; the visit of the Russian squadron under Admiral Avellon to Toulon; the manœuvres on a large scale of the German, English, French and Italian fleets in the autumn; the lamentable sinking of the English battleship Victoria, with the consequent courts-martial and technical investigations; and finally the rebellion of the Brazilian fleet under Admiral Mello, as well as the energetic steps taken by President Peixoto for the creation of an auxiliary fleet; all was well calculated to arouse the interest of the civilized world.

A second characteristic feature of the past year is the extraordinary activity in ship-building of all navies, looking towards the increase and strengthening of fleets, and the visible efforts of individual navies to keep up with the advances of possible enemies. The best example of this is in England, where naval construction was entered upon with unusual energy and on a stupendous scale, with the object of sustaining the naval supremacy of England, even over the allied fleets of Russia and France.

There can be no special mention of particularly significant or startling progress; it is a gradual development of things, the result of practical experience. All powers are continuing to build high-board armored ships, cruisers of high speed, torpedo-catchers and torpedo-boats with little changes in plans. England is an exception, as she has made considerable increase in the displacements of her new vessels, partly to give greater room for powerful engines, partly to widen their field of action. Other nations exceed 10,000 tons displacement only to a slight extent, adhering to their budgets. In ordnance, the muzzle velocity of 800 meters is practically accepted as of the

highest ; although it has been proved that with the very long-calibered guns an initial velocity of 1200 meters can be reached. Important developments in the field of armor plates have been made, which have caused the total abandoning of compound armor of steel and iron. Krupp, in his new nickel steel plates, has created armor of extraordinary resistance to piercing, the equal or superior of all other armors. The process of treatment invented by the American, Mr. Harvey, has produced a superior armor which all the great naval powers are inclined to adopt as soon as the tests are over. The firm of Cammell & Brown has turned to this process of manufacture, having given up the compound armor fabrication.

The fish-torpedo continues to be a formidable weapon, notwithstanding the continued unreliability in its action. With the exception of a few details, no marked improvements have been attained. In most of the great navies experiments have been made in the past year with controllable torpedoes, and in America experiments with a submarine gun have been conducted. In the field of submarine navigation France obtained successful results with the submarine boat Gustave Zédé ; while in America the problem was furthered by means of bids to competitors.

After this general view we will turn to the individual navies and their advances during the past year.

In our own navy, there was little added in 1893 as far as fleet material was concerned, viz., the Hagen, a fourth-class battleship ; a cruiser, second-class, launched at Danzig in the presence of the Emperor ; and the Imperial yacht Hohenzollern. However, the fitting out of the fleet has progressed to such an extent that this year our navy will have ready for duty four armored first-class vessels, the Brandenburg, Wörth, Kurfurst Friederich Wilhelm, and Weissenburg ; and three new armor-clads of the fourth class, viz., Heimdall, Hildebrand, and Hagen. The favorable results of the trial trips of our first-class cruisers have heightened the fighting value of the new kernel of our fleet, and will tend to silence some of the voices in the Reichstag, which complained of the insufficient speed of our battleships, at the same time creating confidence at home and abroad in the capabilities of our government and private ship yards.

A painful vacancy in the list of our men-of-war occurs by absence of the fast protected cruisers, which all great navies deem a necessary part of the fleet. We have not a single armored cruiser, and only four protected cruisers, viz., the Gefion, Kaiserin Augusta, and the older Princess Wilhelm, and Irene. The overwhelming superiority in numbers of the protected cruisers of other nations is shown by the report of the Secretary of the United States Navy, according to which England possesses 63 protected cruisers, France 36, the United States, Russia, and Italy each 13, Chili 5, Japan 11, China 13, Austria 6, Brazil 9, Greece 5, Spain 6. It is difficult to see how we will ever make up this lead unless the Reichstag makes unusual appropriations in the next years for the creation of our cruiser fleet.

A cruiser, fourth-class, is on the stocks at the Imperial docks of Wilhelmshaven, and at the private yard of the Weser Company, of Bremen, an aviso H is building, while the additions to the torpedo-boat fleet are building at the yards of the Schichau firm in Elbing. The modernizing of old fleet material was nearly completed last year and will be finished this year. Extensive changes are planned in vessels of the Sachsen type. Of importance were the final autumn manœuvres of the fleet under Admiral Fr. v. d. Goltz, in which four divisions, each commanded by an admiral, and two torpedo-boat flotillas took part. Heligoland for the first time formed part of the operations.

An important change in the personnel-education was made. The recruits are no longer kept in barracks, but are at once sent aboard ship, where the instruction in seaman's duties commences at once, keeping pace with the military instructions. The advanced instruction takes place in winter when the squadrons are in harbor.

Although the duties of our vessels in the colonies were quietly carried on during the past year, yet the gunboat Hyäne found occasion in December to effect a landing at Cameroon, on the West-African station, in order to put down an uprising of the native police troops. The Alexandrine and Arcona, under the command of Captain Hofmeyer, were at Rio de Janeiro from the beginning of the Brazilian revolution to protect German property and aid the German diplomatic officials. Other vessels on foreign stations kept up their regular cruises. Nevertheless, it is advisable to increase the number of vessels for foreign stations. It is necessary to keep up the prestige of the Empire abroad, and for this purpose a cruising squadron is recommended; also, that two cruisers take the places of the gunboats Wolf and Iltis on the East-Asian station, and a more presentable vessel be sent to the Mediterranean than the side-wheel aviso Loreley. The future will show whether the present force in Cameroon is sufficient.

FRANCE.

The Franco-Russian relations received emphasis through the imposing reception of the Russian squadron at Toulon. The French Navy has finished a year active in ship-building. The following vessels were launched: the battleships Charles Martel and Jauréguiberry, both of 11,882 tons; the second-class battleship Tréhouart, of 6610 tons; the armored cruiser Charner, of 4745 tons; the second-class cruisers Chasseloup-Laubat, Bugeaud, Suchet and Friant, of 3722 tons; the torpedo-cruiser Fleurus, of 1306 tons, and the torpedo-aviso d'Iberville, of 935 tons. All these vessels possess great speed, and will be finished in 1894 and 1895. Building are: first-class cruiser d'Entrécasteaux, of 8114 tons and 14,000 horse-power; second-class cruisers Catinat, of 3988 tons, Duchayla, Cassard, and d'Assas, of 3952 tons; torpedo-aviso Casabianca, of 943 tons; the gunboat Surprise, of 626 tons, and in Cherbourg the submarine boat Morse.

Most of the French vessels are armed with quick-firing guns, and the new long-calibered gun has been placed on some ships. The 37-mm. Maxim gun has been introduced definitely. Trials with a 16-cm. gun of 90 calibers' length, have given the extraordinary velocity at muzzle of 1214 meters per second. A 16-cm. gun burst on board the Duguay Trouin, killing four men. The aviso Bourdonnais was lost off the coast of Madagascar in a cyclone, 4 officers and 23 men were drowned. During the summer months fleet manœuvres on a grand scale were held in the Channel and in the Mediterranean, in which the use of cruisers for scouting and patrolling at great distances was experimented with.

France develops great energy in establishing a powerful fleet, although the latest publications of Clemenceau have caused a fall in public opinion as to the excellence of the French fleet.

ENGLAND.

A dark shadow overlies the year 1893, owing to the catastrophe to the Victoria, under Admiral Tryon. The accident, earnestly deplored by the whole world, has been so often described and its causes given that it is not worth while to come back to it here. It is of interest, however, that the loss of this modern battleship, which brought with it technical investigations, has led to no changes in the construction of English battleships already planned. New uneasiness, however, was caused in English maritime circles by the dangerous behavior of the armor-clad Resolution, of 14,150 tons, during a three days' gale off of Brest last December, en route from Portland to Gibraltar. The vessel rolled so deeply as to come near foundering, and altogether showed little seaworthiness. The same bad features will probably apply to the other battleships of this type. The increase of the English fleet, a public question still in the island, was to preserve England's supremacy against the combined fleets of

Russia and France. The past year has witnessed the completion of the new vessels. Nine vessels of combined displacement of 31,640 tons, besides smaller craft of 2060 tons were launched, or 33,700 tons in all, whereas the average of the five preceding years was 80,000 tons. The ten battleships, built under the Naval Defense Act of 1889, have been finished. Under construction are: 9 cruisers, Edgar type, of 7350 tons and 12,000 horse-power; 21 cruisers, second-class, type Apollo, of 3600 tons and 9000 horse-power. Of the 9 cruisers of the Astrea type, 4360 tons and 9000 horse-power, 6 have been launched. Twelve torpedo-cruisers, 810 to 1070 tons, all except one of which were built by private firms, have also been launched. There will be built no less than 36 torpedo-boat catchers, of the Havock type, of 220 tons, the Havock having had most successful trials. In addition the older battleships Devastation, Sultan, Warrior, Howe, Monarch, Warspite and Vanguard have been rebuilt and modernized. Of great interest was the floating off of the Howe, which had run on the rocks at Ferrera. In England the largest battleships in the world are on the ways at present, the Magnificent and the Majestic, each of 14,900 tons. In the way of cruisers England is also ahead of any other nation by the two gigantic cruisers Powerful and Terrible, of 14,000 tons and 25,000 horse-power, which in a manner are offsets to the Russian cruiser Rurik, and the large American cruisers building. In the department of ordnance new 6-inch wire-wound quick-firing guns, of 40-caliber length, have been adopted. In armor progress has also been made. England has turned to nickel steel, and the firm of Brown & Cammell has large contracts from the Admiralty for plates of the Harvey-Vicker system. The last year differs from its predecessors in England by the laying down of the largest war-vessels in the world. By the construction of a fleet of 36 torpedo-boat catchers, of 220 tons displacement and of great speed, England will, in a short time, be able to mass a flotilla of these formidable vessels wherever she has a squadron of battleships.

RUSSIA.

The formation of a Mediterranean squadron and its visit to Toulon was the principal event. The Black Sea fleet has been strengthened to such an extent and is so far superior to the Turkish fleet that Russians in truth call themselves masters of the Black Sea. The Baltic Sea fleet is also growing annually by new vessels. The most important vessels launched in 1893 are the armorclad Poltawa of 10,950 tons and 10,300 horse-power, at St. Petersbourg; the coast defense battleships Admiral Quschakoff and Admiral Sinjavine of 4126 tons and 4250 horse-power on the Niva; the battleship the Three Saints of 12,500 tons and 20,000 horse-power in the Black Sea; a school-ship and various torpedo-boats. At the government dock-yards in Nikolayeff the keel of an armored battleship of the type of the Three Saints has been laid; it is to be named the Paris. An imperial yacht is building at Copenhagen of 4000 tons and 20 knots. In the early future the keel of a second Rurik will be laid. Rurik I., up to the commencement of the Powerful and Terrible, was the largest cruiser in the world; after completion of her trial trips she will join the Mediterranean squadron. The Russian Navy lost two vessels in the past year, the gunboat Russalka, which went down with all hands in the Baltic, and the cruiser Vitiaz in a Corean harbor.

The opening of the harbor of Liban, which is free of ice, is important for the Baltic fleet. The budget for the Russian Navy amounted to 119 million marks in 1893.

ITALY.

The budget for 1894–95 of the Italian Navy amounts to 80 million marks. The Minister of Marine, Admiral Morin, is evidently bent on increase of the fleet. Of the vessels that went into commission last year first comes the

armored Re Umberto of 13,250 tons and 19,500 horse-power, reaching a speed of 18.2 knots. The trial trips of the Sardegna, similar to the Umberto, have begun. The cruiser Etruria of 2300 tons made 20 knots, the torpedo-aviso Aretusa 20.7 knots. Laid down were the battleships Admiral St. Bon and Emanuel Filiberto of 9802 tons and 13,500 horse-power, a cruiser, and a torpedo-cruiser. Launched were the armored torpedo-cruisers Liguria of 2300 tons and 6500 horse-power, and the Elba of 2731 tons and 6500 horse-power. According to the different journals, the keels are to be laid of three battleships of the first class of 11,000 to 12,000 tons, of three cruisers of 3000 to 4000 tons, and of twelve torpedo-boats. The use of petroleum for fuel was applied with success to several naval vessels. It is even proposed to fit out some battleships for this form of fuel. The liquid fuel is carried in the double bottoms.

AUSTRIA

witnessed the launching of the cruiser Kaiserin u. Königin Maria Theresa of 5000 tons and 9000 horse-power. The keels were laid of three coast defense battleships and of a monitor for the Danube; another monitor, the Szamos, was put in commission. The Schichau built torpedo-cruiser Satellite of 800 tons reached a speed of 21.86 knots with 4900 horse-power.

GREECE, TURKEY AND PORTUGAL

have taken little or no part in the development of the navies.

SPAIN

has commenced the construction of three torpedo-cruisers, type Filipinas, of 850 tons and 20 knots speed. The armored cruiser Infanta Maria Theresa of 7000 tons and 15,000 horse-power developed a speed of 20 knots.

HOLLAND.

is engaged in carrying out its programme for building new ships and has started on three armored coast-defense vessels, the Evertsen, Piet-Hein and Cortenaer of 3400 tons and 20 knots.

IN SWEDEN

trials have taken place of a new small armored vessel, the Thule, of 3086 tons and 3200 horse-power. The keel is to be laid of a similar vessel to carry two 10-inch guns, besides a battery of 5-inch quick-firing guns.

NORWAY

is having built a torpedo-cruiser at Schichau of 380 tons to cost 600,000 crowns, a present of the ladies of Christiania.

UNITED STATES.

Of the non-European navies that of the United States of America is far in the lead. The Navy has in comparatively short time been strongly developed. An astonishing activity is displayed to recover, by means of domestic industry and enormous national wealth, the lost ground. That the Americans will succeed in this is beyond doubt, judging from the progress in the past year. In the American Navy all new inventions and improvements in the naval military field are carefully tested, and adopted whenever they are certain of strengthening the national defenses. In the past year, for instance, exhaustive tests with new rapid-fire guns were made. The trials with the dynamite cruiser Vesuvius seem to be given up. The fleet was increased by a number of vessels. Launches took place of the battleships Massachusetts,

Indiana and Oregon of 10,200 tons and 9000 horse-power; of the cruiser Minneapolis, 7350 tons and 21,000 horse-power, and of the ram Katahdin of 2183 tons and 4800 horse-power. In addition, the old monitors Amphitrite, Terror and Monadnock are being modernized. Building are: the battleship Iowa of 11,996 tons and 11,000 horse-power, the cruiser Brooklyn of 9153 tons and 16,000 horse-power, and two gunboats of 1600 to 1700 tons. That the American vessels are at the top is shown by the results of the trial trips. The coast defense vessel Monterey of 4136 tons and 5400 horse-power made 16 knots; the armored cruiser New York of 8150 tons, 16,500 horse-power, made 21 knots; the cruisers Detroit and Marblehead of 2000 tons and 5400 horse-power made 18 to 19 knots. The protected cruiser Columbia of 7350 tons and 21,000 horse-power, triple screws, is said to have reached the speed of 22.4 knots, making her the fastest cruiser of the world.

ARGENTINE AND CHILI

have received additions in the protected cruisers 9 de Julio of 3750 tons, and the Blanco Encalada, built by Armstrong Company.

BRAZIL

commands attention merely on account of the interest aroused by the present operations of its fleet. A new school-ship was built in France, the Benjamin Constant. The cruiser Almirante Barroto was lost at Suez, and the monitor Javary foundered in the Bay of Rio.

CHINA AND JAPAN.

In the far east the navies of China and Japan may be noticed. Very slow progress is made in China, but Japan exhibits activity in fleet development similar to that in the United States. It is making steady progress and gives surprise by its excellent organization and good ships, which latter are mostly built in Europe. Two battleships, a cruiser and an aviso are planned. The cruiser Yoshino of 4000 tons, built by Armstrong, made 21.6 knots on the trial.

In general, it may be stated that there is marked increase in fleets and appropriations for developing navies.

SHIPS OF WAR OF THE UNITED STATES.

THE MINNEAPOLIS.

The official report of the Naval Board of Inspection which conducted the sea trial trip of the Minneapolis has been made public. The report is exhaustive, and in detail one of the most carefully prepared of any records of the kind on file in the Navy Department. Before the run commenced the vessel had a draft of 22 feet 1 inch forward, 23 feet 4 inches aft, or 22 feet 8½ inches mean, which by the curves worked out represented a displacement of 7475 tons. Upon the return trip the mean draft had become 22 feet 3 inches and the displacement 7300 tons. The first run of 87.936 knots was made in 3 hours 49 minutes and 2 seconds. Counting tidal correction the mean official speed was 23.073 knots per hour. It was found that the ship's tactical diameter was approximately 800 yards and that she could turn through 16 points in 2 minutes and 50 seconds, and within five or six times her length.

She is one of the very fastest war vessels afloat, and has earned Messrs. Cramp, of Philadelphia, her builders, a bonus of $400,000, in addition to her contract price, which was $1,690,000.

The Minneapolis is one of the few cruisers that are provided with triple screw propellers, among the others being the Columbia, the French Dupuy de Lôme, and the German Kaiserin Augusta.

She was launched on August 12th, 1893, and is 412 ft. long, with 58 ft. beam, a horse-power of 21,000, and is known as a commerce destroyer. Her heavy armament consists of one 8-in. gun and two 6-in. and eight 4-in. quick-firers. She has in addition a dozen 6-pounders, four 1-pounders, and four Gatling guns, as well as five torpedo ejectors. She is protected by a sloping armored deck 4 in. thick at the sides, and has a double bottom minutely subdivided into water-tight compartments. The engines and machinery will be further protected by patent fuel, which will be packed around them to the thickness of 5 ft.

With her center screw only revolving, the Minneapolis can get along at the respectable speed of 10 knots with a very economical expenditure of coal. Of this she is said to carry no less than 2400 tons, and is able to steam 15,000 miles without re-coaling, so that the mischief she would be enabled to inflict on the mercantile marine of an enemy before she was likely to be caught would be almost incalculable.

ENGLAND.*

THE MAGNIFICENT AND MAJESTIC.

The two fine battleships which are building respectively at Chatham and Portsmouth, the Magnificent and Majestic, are progressing with rapid strides. The disposition of their armor is of a very different character from that employed even in the most recent battleships. The side armor is not vertical, but slopes backwards to a considerable degree, the French plan of making the ship's sides "tumble home" having been adopted to a modified extent by the constructive department of the Admiralty.

The old plan of starting the armored side streak a few feet below the surface of the water has been adhered to, the thickest portion of the steel plates reaching to the level of the flat lower deck, which rests upon the crown of the arch of the armored lower deck. Thinner steel armor is carried up to the level of the main deck. But the most important modifications are in the armored deck and barbettes. The armored deck, instead of being a mere flat roof to the citadel, curves downwards on each broadside to the armor shelf, or lower edge of the side armor; so that, in addition to having the side armor to penetrate, a projectile would meet with 4 in. of steel set at an angle which would give a further reinforcement of about 6 in. to pass through. The height of the curve of the armored deck is about 9 ft., and it extends unbroken from forward apex to after apex of the citadel. (The citadel has a curve in the bulkhead, forward or aft, around the corresponding barbette.) It will thus be seen that the outer edge of the armored deck stretches from stem to stern in a horizontal line. This is a most invaluable feature of the new designs, and was never attempted before, the horizontal line of the armored deck being raised above the citadel in all earlier battleships. The barbettes rise at either end of the citadel, and are pear-shaped, passing upwards through main and upper decks, beyond the latter of which they project a little, and upon their summits will be revolving armored hoods or turrets, as in the cases of the Barfleur and Renown. The bulkheads of armor which enclose the ends of the citadel are in reality merely a prolongation of the side armor, which is carried round thus to meet the barbettes at the central line, and they enclose the curved slope of the armored deck, being built against it.

Another important feature of improvement which is observable in these ships is the greatly extended inner skin. It reaches unbroken to two bulk-

*The details of foreign ships of war are from *Engineer* and *Engineering*.

heads some 8 ft. or 9 ft. forward and aft of the apices of the citadel, and is thus very much more effective than in any ships previously designed. The unprotected ends of these two new battleships really sink into insignificance. The extent of armored surface from apex to apex of the citadel is nearly 300 ft., and it is almost inconceivable that any injury to the unprotected portion would be of so serious a character as to affect the trim or stability of these vessels to a dangerous degree.

The engines for the two other battleships to be built in the dockyards will be given out to contract later. All these battleships, it may be added, are 10 ft. longer and of correspondingly greater displacement than the Royal Sovereign class. The new vessels, which were designed by Dr. W. H. White, of the Admiralty, are 390 ft. long, 75 ft. beam, and have a load draught of 27 ft. 6 in. with 900 tons of coal in the bunkers, when the displacement is 14,900 tons. The weight of hull is 10,180 tons, and the broadside will be covered from under the water-line to the top deck with Harveyed plates 9 in. thick, the depth extending to about 15 ft. The armament consists of four 12-in. breech-loading guns, mounted in pairs *en barbette*, and armored with 14-in. Harveyed plates, and in addition there will be twelve 6-in. and twenty-four smaller quick-firing guns. The machinery is designed to develop, under natural draft, 10,000 indicated horse-power, giving a speed of 16.5 knots, and under forced draught, 12,000 indicated horse-power, giving a speed of 17.5 knots.

THE HERMIONE.

H. M. S. Hermione has completed her steam trials with most satisfactory results. The cruisers, of which eight have been built in the dockyards under the Naval Defense Act, and are improved Apollos, and are wood-sheathed and copper-bottomed. The length is 320 ft., beam 49 ft. 6 in., and at 19 ft. mean draught the displacement is 4360 tons. They are 20 ft. longer than the wood-sheathed Apollos, and of considerably greater beam (5 ft. 10 in.), so that in the latter case the length is nearly seven times the beam, and in the Hermione 6½ times. The draught is more by 2 ft. 6 in., and the displacement 760 tons greater. The weight of the hull is 2460 tons. The protection is the same—by a deck about the water-line, 2 in. thick on the sloping parts and 1 in. on the level, and the arrangement of bunkers—but the freeboard is greater, and the comfort of the crew and the seaworthiness of the cruiser generally increased. There are a larger number of auxiliary guns, the armament consisting of two 6-in. quick-firing guns, bow and stern chasers, eight 4.7-in. quick-firers discharging on the broadside, eight 6-pounder and one 3-pounder quick-firers, four machine guns, and one boat gun. There are two fixed torpedo-launching tubes, and two launching cars. The engines are practically of the same design as those fitted in the three cruisers of the Apollo type, built and engined three years ago by the same company under the Naval Defense Act—the Thetis, Tribune, and Terpsichore—the results alike as regards power and steady working commending the arrangement for adoption in the slightly larger cruiser. There are eight single-ended return-tube boilers, as in these three cruisers; but though the heating and grate surfaces of the boilers are about the same, the boilers themselves are nearly 10 per cent. larger, the increased dimensions being taken up by wider spacing of tubes and extra steam capacity. At the official steam trials the results were satisfactory. The mean power on natural draught, with .45 in. air pressure, was 7393 indicated horse-power, while the contract was for 7000; and on the forced draught trials with .94 pressure, 9264 indicated horse-power, the guarantee being 9000. The designed speed of 19½ knots was also exceeded. The details of the trials are appended:

Eight Hours' Natural Draught Trial in the English Channel, May 10, 1894.

Hours.	Revolutions.		Boiler Pressure. lbs.	Vacuum.		Air Pressure. in.	Indicated Horse-Power.		
	Starboard.	Port.		Starboard.	Port.		Starboard.	Port.	Total.
1st,	126.3	126.8	135	26.5	26.5	.5	3411	3465	6876
2d,	128.2	128.5	142	26.5	26	.46	3765	3747	7512
3d,	129	129.2	139	26	26.2	.45	3801	3688	7495
4th,	129.1	128.9	140	26	26	.42	3630	3574	7204
5th,	130.4	129.8	136	26.2	26.5	.47	3768	3669	7437
6th,	130.9	131.2	144	26.5	26.5	.4	3908	3829	7737
7th,	128.2	129.8	142	26.5	26.5	.45	3735	3778	7513
8th,	126.8	126	141	26.5	26.5	.45	3717	3657	7374
Means,	128.6	128.8	140	26.3	26.3	.45	3717	3676	7393

Four Hours' Forced Draught Trial in the English Channel, May 12, 1894.

Half-Hours.	Revolutions.		Boiler Pressure. lbs.	Vacuum.		Air Pressure. in.	Indicated Horse-Power.		
	Starboard.	Port.		Starboard.	Port.		Starboard.	Port.	Total
1st,	135.8	135.5	142	26.5	26.5	.70	4521	4392	8913
2d,	136.1	136.4	143	26.5	26.5	.89	4542	4452	8994
3d,	137.1	137.	144	26.5	26.5	.95	4547	4700	9247
4th,	138.1	137.5	143	26.5	26.5	1.02	4706	4695	9401
5th,	138.2	137.4	144	26.5	27	97	4652	4595	9247
6th,	138.4	137.2	145	27	27.5	.90	4622	4607	9229
7th,	138.7	138.4	145	27	27.5	1.15	4780	4677	9457
8th,	138.6	137.9	146	27	27	.97	4777	4844	9621
Means,	137.6	137.2	144	26.7	26.9	.94	4643	4621	9264

THE CHARYBDIS.

Her Majesty's ship Charybdis, a second-class cruiser for the British Navy, has undergone her official steam trials at the mouth of the Thames with satisfactory results. She is a ship of 4360 tons displacement, armed with 10 guns, and differs from the Apollo class in having an additional upper deck sheltering her main armament, and providing superior accommodations for her crew. On her natural draught trial, with an indicated horse-power of 7109, a speed of 19.3 knots was attained, and with 9136 indicated horse-power on the forced draught trial, a speed of 20.5 knots. The ship has been built at Sheerness Dockyard.

THE HUSSAR.

The torpedo-gunboat Hussar, one of the 18 vessels of her class provided for under the Naval Defense Act of 1889, was successfully launched on the 3d July, at Devonport. Ten vessels in all have been launched at Devonport under the Defense Act during the past four years, the new gunboat completing the programme. The Hussar is officially described as a first-class torpedo gunboat, unprotected. Her dimensions are: Length, 250 ft.; breadth, 30 ft. 6 in.; mean load draught, 9 ft.; weight of hull, 555 tons; displacement, 1070 tons; coal capacity, 100 tons. The propelling machinery consists of two sets of triple-expansion surface-condensing engines of the vertical inverted type. The engines are capable of developing a collective horse-power of 3500 on a three hours' forced draught trial, and 2500 horse-power on an eight hours' natural draft trial. The propellers are of the three-bladed type, and will make 250 revolutions a minute, which will give an estimated speed of 19

knots with the 3500 horse-power, and 17 knots to 17.5 knots with the full natural draught power. The armament of the Hussar consists of two 4.7-in. and four 6-pounder quick-firing guns, one bow torpedo tube, and two double revolving broadside torpedo-tubes. The armament alone will cost 8355*l*. The total estimated cost of the vessel is 78,038*l*, of which 1610*l* is due to increased rates of pay to workmen. Designed by Mr. W. H. White, Director of Naval Construction, and laid down on April 3, 1893, she is to be completed and in the Fleet Reserve as ready for sea during the present financial year.

THE FERRET.

The official full power forced draught trial of H. M. S. Ferret, built by Messrs. Laird Brothers, of Birkenhead, took place on the 10th July at Skelmorlie, on the Clyde, with very satisfactory results. The mean speed on the measured mile at Skelmorlie on six runs gave 27.62, the maximum speed attained being 28.4 knots. The speed for the three hours was 27.51 knots, with 175 lbs. steam and 361 revolutions. The Ferret is the first of the new class of 27-knot torpedo-boat destroyers ordered subsequently to the Hornet, and is of larger dimensions, her displacement on trial being 258 tons.

TORPEDO-BOAT NO. 97.

No. 97 torpedo-boat, built by Laird Brothers, Birkenhead, went on her three hours' full power official trial at Skelmorlie, with highly satisfactory results. Six runs were made on the measured mile as follows:

Mile.	Steam.	Vacuum.	Revolutions.	I. H. P.	Speed.
First,	176	24.5	355.3	1658	23.377
Second,	172	24.5	364.3	1682	24.000
Third,	176	25	362.3	1704	23.529
Fourth,	174	25	367.2	1732	24.161
Fifth,	167	25	360.7	1650	23.226
Sixth,	163	25	356.1	1628	23.529
Means,	171	24.8	361.1	1675	23.709

The speed for the three hours was well maintained, showing a considerable excess over the contract speed of 23 knots.

THE NEW THORNYCROFT TORPEDO VESSELS DARING, DECOY AND NO. 92.*

During last week two trials were made on the measured mile off the Maplin Sands, that should prove memorable in the annals of marine engineering and naval construction. In the first of these to which we shall make reference, the record of speed afloat has been very largely advanced, all previous performances in this field having been beaten by no inconsiderable amount. The Daring is a torpedo-boat destroyer, which Messrs. J. I. Thornycroft & Co. have just completed for the Royal Navy, and on Saturday last the vessel was taken down river for a progressive series of trials. In the course of these she made on one run on the mile the remarkable speed of over 29 knots when steaming against tide, although doubtless the current was not strong. It is satisfactory to know that this "fastest craft afloat" has been built for our own Government, for so many of the highest-speed craft constructed in this country have been sent abroad. The Daring is one of the 42 vessels of her class which have been ordered during the last two years. She is 185 ft. long, 19 ft. wide, and 13 ft. deep, and has been designed by Messrs. Thornycroft, both in regard to hull and machinery. The vessel shows a fine bold side for her inches, having a freeboard of 7 ft., and has, of course, a flush deck. The height above water makes her a dry vessel when running at speed, as was

* *Engineering*, June 29, 1894.

proved during the trial. There was, indeed, nothing that could be described as a heavy sea on during the trial, but the waves were quite big enough to have sent a good deal of loose water flying across the deck, when steaming with the wind ahead, had the boat not been well-designed in this respect. The flush deck extends to the conning tower forward, beyond which there is the usual turtle-back over the fore-peak, as in the ordinary first-class torpedo-boat design. The arrangement of the Daring, however, differs from the torpedo-boat design in regard to a breast-work at the end of the turtle-back, and extending right across the deck. This affords an excellent shelter to those forward when steaming head to sea.

The Daring, like all her sisters, is a twin-screw boat, and there is one important fact in regard to the business of boat-destroying, for which the vessels are intended, should they ever be called upon for practical work. The draught of the larger single-screw torpedo-boat is 7 ft. 6 in., whilst the Daring draws but 7 ft., so that in action the smaller craft would not be able to take advantage of shallow water as a haven of safety. The vessel has what should be described as the Thornycroft stern, although it is sometimes flippantly alluded to by the irreverent as the "flat-tailed" or "inverted pudding-basin" type. The breadth is carried well aft on the water-line, though there is a good deal of tumble-home at this part, and the end being round, the view end-on is somewhat unusual. In order to secure an easy delivery, the floor is sloped up from near amidships to the extreme end, where it is only just immersed, so that the model may be described as that of a horizontal wedge aft and a vertical wedge forward. This principle of design, although somewhat unusual in steamers, is well known to give very good results, both in regard to speed and rough-weather qualities, for small sailing vessels, as may be instanced by the north-east cobles and the New England fishing schooners. In the Thornycroft design, however, the floor aft is not only flat, but actually concave in the 'thwartship direction. This, in conjuction with the tumble-home, gives a sharp knuckle or chine where the side joins the bottom. It has been objected that in a heavy sea the falling of the stern would cause a heavy blow on the bottom, but in practice this has not been found to be the case, as the boat in her passage appears to cut through the waves and smooth the water sufficiently to overcome this difficulty. The two propellers are carried under the arched bottom, the shafts projecting through, and there are two suspended rudders, one hung on each quarter in the same 'thwartship line as the propellers, to which they thus act as guards.

On last Saturday's trial a very numerous party, no less than 73 people all told, was on board, and with 19 tons of coal in the bunkers, the displacement was 228.6 tons. The armament of these boats consists of one 12-pounder quick-firing gun, carried on the conning-tower forward ; five 6-pounder quick-firing guns on the broadside, and another in the center line on a special mounting aft. There are three torpedo-dischargers for 18 in. torpedoes, one built in the bow, and two discharging carriages on deck aft, and arranged as a pair. Each vessel will carry five torpedoes, three in position, and two stowed under the turtle-back forward.

The engines of the Daring and her sister vessel the Decoy, now also finished, are an interesting feature, being of a new type designed by Messrs. Thornycroft for these vessels, and the first-class torpedo-boats just completed. They are of the three-stage compound type, and have cylinders 19 in. in diameter for the high-pressure engine, 27 in. for the intermediate, and a pair of 27 in. in diameter for the low-pressure. The stroke is 16 in. Each set of engines may be said to be divided into two parts. Thus the high-pressure and intermediate cylinders form one half, whilst the two low-pressure cylinders form another. The cylinders are inclined from the vertical alternately to the right and left. Piston valves are not used, but the larger surfaces of the flat slide valves are balanced to relieve the pressure on the back. Following the line of the engines, we have first the eccentrics and link motion which work the slide

valve of the high-pressure cylinder, which are run on an overhung part of the shaft. There is next a main bearing, after which come the high-pressure and intermediate cranks. Immediately aft again is another main bearing, and then the eccentrics for the intermediate slide valve, which are followed by the forward low-pressure eccentrics. Another main bearing follows, and then the two low-pressure cranks, after which another main bearing, and then the after low-pressure eccentrics, beyond which is the thrust block. The inclined position of the cylinders enables the axes of the cylinders to be brought close together in a fore-and-aft direction, and advantage is taken of this to introduce an arrangement of cranks that is certainly unusual for torpedo-boat practice. In place of there being a separate two-web crank for each cylinder with a length of shaft between, there are three webs to the two crankpins, the centre web being common to both, and receiving a crankpin at each end. The centre web has naturally to be twice as long, or nearly twice as long, as each of the others—the cranks being almost opposite to each other—and it may be said, therefore, that the cranks are double webbed. It will be seen that by this arrangement there is a considerable gain in fore-and-aft space occupied, no inconsiderable advantage in craft of the torpedo-boat type, where machinery occupies all the best part of the boat.

Another notable feature in these engines is the manner in which the standards are arranged. The majority of us remember the revolution Mr. Thornycroft wrought in the design of engine framing by the introduction of wrought-iron or steel pillars and diagonal bracing, a principle which was first applied, if we remember rightly, in the case of the Miranda. The principle adopted in the little river yacht found universal application in fast-speed vessels, and has influenced all classes of marine engines. The design may now be said to have become classic, as it is superseded in the Daring's engines by a still more open description of framing. In the new arrangement the main standards are placed close to the fore-and-aft center line of the cylinders, and may be described as prolongations of the main bearing bolts; indeed, they serve the latter purpose, as the keeps of the main bearings are held in position by means of nuts screwed on to the bottom end of the standards or bearing bolts. By slacking up the nuts the keeps can be raised, and the bearings are thus exposed. The standards are stiffened by inclined struts. There is no bedplate to these engines in the ordinary acceptance of the term, but round one side, extending from end to end, there is a continuous steel casting connecting the main bearings. On the other side there are, to each set of engines, two flat steel castings which run from one pair of standards to another, and are attached to the bottom ends of the crosshead guides. In this way there is one of these deep steel ribs to each half of the set of engines, namely, one embracing the high and intermediate cylinders, and one common to the two low-pressure cylinders. There are two air pumps, worked by side levers, to each set of engines, all other pumps being entirely independent. The question of vibration has been kept in view in these engines, the design being worked out so as to reduce the unbalanced forces to the smallest degree possible. Judging by results, Mr. Thornycroft has been entirely successful in this, for the steadiness of the boat when running at her highest power was almost as remarkable a feature as her extraordinary speed; indeed, the usual phenomena in this respect that formerly accompanied the running of lightly-built high-powered vessels were almost absent, there being apparent none of the usual periods of synchronization of hull and engines at varying revolutions, excepting, perhaps, to a small extent at a lower speed. It would seem, indeed, that the boat had nothing to synchronize with.

The boilers of the Daring are three in number. The total heating surface is close upon 8000 square feet, and the grate surface is 189 square feet. The boilers are placed in two stoke-holds, the forward one having two boilers and the after one a single boiler. The whole of the feeding is done by one Weir's

pump placed in the engine-room, there being, however, additional pumps to be used in case of accident. In order to solve the difficult problem of feeding a group of water-tube boilers from one pump, Messrs. Thornycroft have devised an automatic feed control, upon which we shall have more to say at a later date. For the present it will be sufficient to remark that throughout the trials there was no difficulty in regard to the distribution of feed, and it would seem that Mr. Thornycroft may, therefore, be congratulated on having solved a very knotty problem. The blades of the propellers, three to each screw, are of phosphor bronze, keyed into a boss in a novel manner; it having been found by experience that phosphor bronze requires somewhat different treatment to steel.

Having so far described the main features of the vessel and her machinery, we will proceed to a brief record of Saturday's trial. The vessel left Chiswick by the early morning tide, and calling at the Temple Pier, took on board the guests who had been invited to witness the trial. Easy steaming and moderate speed was maintained until the Lower Hope was reached, and down Sea Reach a fast spin was tried to see that all was working well. On reaching the Maplin mile the revolutions were reduced to a mean of 91 per minute, at which rate of steaming the observed speed was 7.86 knots. The engines were then opened out until they were running at 175 revolutions when the speed was 14.2 knots. At 238 revolutions the speed was 18.3 knots. After this the revolutions were raised to 322 per minute, with which a speed of 23.4 knots was attained. Three runs were made at each of the stated revolutions.

The final supreme test of the vessel was now to be made. The engines were fully opened out, and a short run was made in order to raise steam to full pressure and work the engines up to their best speed. The boat was once more put on the mile against the tide, which, however, did not appear to be running with very much force, to judge by the appearance of the Admiralty buoys which serve as steering marks. The steam pressure on this run was 200 lbs., the mean revolutions were 382.9 per minute, and the time occupied between the section posts was 2 minutes 7.5 seconds; the speed being, therefore, 28.214 knots. The boat was turned and the second run was entered upon, the steam being again 200 lbs. The time occupied in making this trip was 2 minutes 6 seconds, the revolutions averaging 385.7 per minute, the speed, therefore, being 28.571 knots. The vessel was once more turned and the third run was entered upon with the safety valves from both boiler-rooms blowing. The time occupied on this run was 2 minutes 3 seconds, the revolutions were 395.1 per minute, and the steam pressure 215 lbs. The speed, therefore, reached the hitherto unequalled rate of 29.268 knots. This run was made against tide, doubtless a slack one, but certainly there was some current meeting the boat. It will be seen that the mean of the three runs gives a speed of 28.656 knots, and 384.3 revolutions. The guaranteed speed of the boat was 27 knots.

It is to be regretted that this last trial, at full speed, was not extended to the usual six runs on the mile, for, had it been so, there is little doubt that the mean speed would have been much increased. We think that too little time was taken in working up the rate of steaming before going on the full-speed trial, and this opinion is borne out by the records, and also by the fact, that the safety valves were lifting on the last run. The afternoon, however, was drawing in, and Mr. Thornycroft had promised one of his guests that he should be back in time to fulfil an engagement. If the Daring made 29¼ knots against tide, however slack, it is fair to suppose she would do at least equally well on a series of runs "with and against." The indicator cards taken on the last run worked out to 4842 indicated horse-power, which, it may be remarked, is 142 units more than was attained by the Speedy on her trial.

We have said "*if* the Daring made 29¼ knots," but we do not mean to imply by the "doubting word" that there is any question about the per-

formance. The times were taken by Messrs. Pledge and Harding, on behalf of the Admiralty, as well as by Mr. Barnaby for the builders of the boat. Perhaps, however, no trial of a vessel was ever more extensively "clocked." If there was an error in the observed times, it was on the last run. One gentlemen—not unknown in the annals of sport, and who prides himself on his skill in "clocking" maintained that the last run was made in 2 minutes 2¼ seconds, and seemed not a little scandalized that the extra fifth of a second should be given against the boat.

It may be interesting to state, in regard to these progressive trials, that Mr. Barnaby had previously constructed a speed and power curve on theoretical data founded on the results of former experiments. This he had brought down to the trial, and it was found, after the actual results obtained were plotted out, that the curve thus obtained was all but identical with that worked out previously. The incident is useful as showing the reason of the success obtained by experienced torpedo-boat builders, for there is nothing that more tends to success than knowing beforehand what is required.

The other vessel to which we made reference in our opening paragraph as being tried last week, is the first-class torpedo-boat No. 92, one of three that have recently been completed for the Admiralty by Messrs. Thornycroft & Co. No. 92 has a single screw, and is 142 ft. 6 in. long, 15 ft. 6 in. wide, and draws 7 ft. 6 in. of water. She has one set of engines, similar to those of the Daring. Her displacement was 129 tons, the load being 24 tons. The guaranteed speed was 23.5 knots, but on trial she made rather more than a knot over her contract speed, namely, 24.522 knots. The steam pressure was 220 lbs., and the engines exerted 2600 indicated horse-power, which, it will be seen, is even a better performance than either of the Daring's engines to the extent of 179 indicated horse-power, if we divide the power of the latter's two engines equally between the two; or, in other words, the Daring's power would have been 5200 horse-power in place of 4842 horse-power, if both her engines had done as well as the torpedo-boat's engines. No. 92 has two boilers of the Speedy type, which we have previously illustrated.

This vessel is now, we understand, the fastest torpedo-boat in the Royal Navy, and it is worthy of notice that Messrs. Thornycroft, in the last three torpedo-boats they have tried, have successively reached the highest speed for vessels of this class built for the Admiralty. The other boats are Nos. 91 and 93. The former of these two was tried on the 5th inst., and is also a single-screw boat. She made a mean speed on the measured mile of 23.71 knots, although the mean of one pair of runs on the mile was 24.716 knots. The mean speed during the three hours was 23.74 knots, and the maximum indicated horse-power 2639, or even more than in the case of No. 92. The remaining vessel of the three, No. 93, is a twin-screw boat, which was delivered in December last. She made 23.84 knots on the measured mile, and 23.59 knots during the three hours' run. Of these two it was found that the twin-screw boat required rather less power than the single screw for the same speed.

The results we here chronicle are very gratifying to us in this country in view of the big things promised by some of our competitors abroad. We are glad to see English torpedo-boat builders so ably holding their own, and trust it may be long before supremacy will be wrested from the country in which the modern high-speed torpedo-boat originated. Doubtless the competition is keen and the pace hard, for there are those pressing on our heels who will give no opportunity of resting on our laurels. For this reason, perhaps, we may have reason to be glad that there is an honorable rivalry even within our own borders; and if the torpedo-boat builders themselves think they have occasion to cry out at the unceasing effort they have to maintain, it may be some consolation to them to know that their labors have a far wider result than the construction of little war-vessels that may never be used; for the great advances in marine engineering of the last 20 years have sprung largely, if not chiefly, from torpedo-boat practice.

FRANCE.

LE CARNOT.

The great French battleship, which was laid down at the arsenal of Le Mourillon, Toulon, in July, 1891, as the Lazare Carnot, but which henceforth, in memory of the assassinated President as well as of his grandfather, is to be called Le Carnot, was launched on Thursday, the 12th of July. She is practically a sister ship to the Charles Martel, which was launched at Brest on August 28, 1893. The length of the vessel is 396 ft., her beam 71 ft., her draught aft 27½ ft., and her displacement 11,882 tons. She has a complete steel belt with a maximum thickness of 17.7 in., and a curved steel deck 2.75 in. thick. Above the water-line belt there rises, for an additional height of 4 ft., a steel belt of 4-in. armor. The machinery of the ship consists of a pair of compound vertical engines with three cylinders, fed by 24 Lagrafel and d'Allest boilers. At 95 revolutions with forced draught, 13,500 horse-power should be developed, giving a speed of 18 knots, and with 85 revolutions, with natural draught, 9500 horse-power, giving a speed of about 17 knots. The machinery weighs 1178 tons. The normal coal capacity is 800 tons, or enough for 4000 knots steaming, but when all subsidiary bunkers are full, coal for 5000 knots can be carried. The cost of Le Carnot will be, for the ship 960,000*l.*, for her gun and torpedo armament 104,000*l.*, and for machinery and boilers 127,200*l.*; or, in all, 1,191,200*l.* The armament will consist of two 11.8-in. guns, one in a 14.6-in. turret forward, and the other in a similar turret aft, the forward gun being 26 ft. and the after gun 19.5 ft. above the water-line; two 10.6-guns, one in a 14.6-in. turret on each beam, eight 5.5-in. quick-firing guns, mounted singly in 3.9-in. turrets, four on each beam, four 2.5-in. quick-firing, twelve 1.8-in. quick-firing, and eight 1.45-in. quick-firing or Maxim automatic guns. There will also be four above-water and two submerged torpedo-launching tubes. The most significant feature of the vessel is the enormous power of her right ahead and right astern fire. In each case this is furnished by one 11.8-in., two 10.6-in., and four 5.5-in., besides smaller guns. Beam fire is furnished by two 11.8-in., one 10.6-in., and four 5.5-in. guns, so that in every direction the ship is offensively strong to an exceptional degree. In this respect England has nothing that can compare with her.

THE JAURÉGUIBERRY.

[*Engineering.*]

The Jauréguiberry is the second battleship of the French Navy in which all the firing and turret manœuvres will be executed by electricity or by hand, hydraulic machinery being suppressed. The Jauréguiberry has twin screws driven by two triple-expansion engines, each of 6250 horse-power; she is 356 ft. long, and is intended to attain a maximum speed of 17 knots. She carries, fore and aft, one 11.18-in. (30-centimeter) gun mounted in turrets, and on each side nearly in the middle of her length a 10.63-in. (27-centimeter) gun; there are, in addition, four turrets, each containing two 5.51-in. (14-centimeter) quick-firing guns (these are on the Canet breech-loading system). The arrangement, which it is claimed, insures a maximum efficiency in training the heavy armament, is due to Mr. Lagane, naval architect to the Forges et Chantiers de la Mediterranée of La Seyne.

Both in advancing and retreating manœuvres, at least one 30-centimeter, two 27-centimeter, and four 14-centimeter quick-firing guns are always available. For broadside firing, the battery consists of two 30-centimeter, one 27-centimeter, and four 14-centimeter quick-firing guns. Of lighter armament there are four quick-firing 2.56-in. (65-millimeter), twelve 1.85-in. (47-millimeter), and eighteen 1.46-in. (37-millimeter) machine guns. The armament

is completed by six torpedo-firing tubes; four of these, of steel, are placed two forward and two nearly amidships; the other two, of bronze, are placed below the water-level, and are of a special type. In the armament may be also included eight electric search-lights and Mangin projectors.

After the completion of the Chilian battleship Capitan Prat, and the successful results attending the trials of that ship, the French naval authorities confided to the Forges et Chantiers de la Mediterranée the construction of the Jauréguiberry, including all the gun mountings and a part of the armament.

The Jauréguiberry was commenced in 1891, and was launched on October 27, 1893, 23 months later, when she was somewhat more than half completed. Probably she will be ready for the first trials in July, 1895. The following are some of the principal dimensions of this vessel:

Length between perpendiculars.....	356 ft.
Width.....	72 ft. 8.05 in.
Draught of water amidships.....	26 ft. 6.91 in.
" " aft.....	27 ft. 8.69 in.
Normal power of machinery.....	13,000 horse-power.
Speed "	17 knots.

Approximately the weights of the Jauréguiberry are:

	Tons.
Steel framing of hull.....	3317
Armor-plate and bolts.....	4008
Miscellaneous.....	593
Engines.....	421
Boilers.....	421
Water for engines and boilers.....	119
Guns and torpedoes.....	995
Fuel.....	700
Military masts and rigging.....	171
Fittings, etc.....	451
Extra.....	263

The sides of the ship, as far as the top of the armor backing, are of steel, varying in thickness from 0.63 in. to 0.71 in.; above the armor-plate the thickness is reduced to 0.31 in. and 0.39 in. There are a false central and two lateral keels about 150 ft. in length. Beneath the armored deck the construction includes a double bottom, except in the engine and boiler spaces. The safety of the ship is increased by 13 transverse and one longitudinal bulkheads, while the coal stores are placed so as to afford protection to the engines and boilers. The principal armor belt covers the ship from end to end; this belt is 6 ft. 6.74 in. deep amidships, the depth being increased forward. The lower edge of the armor belt is 4 ft. 11 in. below the water; it is 17.72 in. thick amidships, reduced to 7.87 in. and 9.84 in. fore and aft.

There are 24 multitubular boilers, on the Lagrafel and D'Allest system; they are arranged in 12 groups of two. These are distributed in six stokeholds. They are registered for a pressure of 15 kilogrammes per square centimeter (213 lbs. per square inch), and were tested cold to 300 lbs.; they are constructed of Siemens-Martin steel with iron tubes. The total grate surface is 1085 square feet, and the heating surface is 35,092 square feet. The production of steam with natural draught corresponds to a total horse-power of 13,200, which is sufficient for driving the main engines and furnishing the supplementary power required in the vessel. The maximum horse-power under forced draught is 14,200. The consumption of coal per horse-power varies from 1.54 lbs. to 2.09 lbs., according to the power developed by the main engines of from 8000 to 14,200 horse-power; this corresponds to a con-

sumption of coal per square foot of grate of 22.55 lbs. with natural draught, rising to about 30 lbs. per square foot under forced draught. If these figures are correct, it would appear that the coal supplies carried by the Jauréguiberry are only sufficient to enable the minimum power of 8000 horse-power to be maintained during 100 hours, or during 50 hours at 13,000 horse-power, at a speed of 17 knots, and representing a total distance of about 1000 miles.

The six stokeholds of the vessel are separated from each other by water-tight longitudinal and transverse bulkheads. The boilers are fed by 12 Thirion feed pumps, taking their supply from tanks through sponge filters. The following are the general particulars of the boilers:

Number of generators	24
" furnaces per generator	1
Grate surface in each furnace	45.21 sq. ft.
Total grate surface	1085 "
Heating surface per generator	1459 "
Total heating surface	35,092 "
Outside diameter of tubes	3.15 in.
Number of tubes per boiler	213
Distance between tube-plates	8 ft. 0.46 in.
Total number of tubes	5112
Water space in boilers	2881.83 cubic feet.
Steam space in boilers	2941.87 "

The approximate weight of the boilers is as follows:

Twenty-four generators	235 tons.
Smoke-boxes, etc.	99 "
Feed pumps, flooring, etc.	138.3 "
Water in tanks, condensers and boilers.	119.6 "
Total	591.9 tons.

The motive power consists of two vertical triple-expansion engines, each driving a separate screw. The horse-power of each engine with natural draught is intended to be 6250, or 12,500 horse-power for the two engines; it is calculated that at a speed of 97 revolutions per minute the vessel should be driven, as stated, at a rate of 17 knots.

The high-pressure cylinders receive steam from the boiler at a pressure of 170 lbs. per square inch; this is reduced to 85 lbs. and 57 lbs. per square inch in the intermediate and low-pressure cylinders. The high-pressure and second cylinders are provided with piston valves, and the low-pressure cylinder with two slide-valves. The pistons are of cast steel with cast iron rings.

The following are some of the principal dimensions of the main engines:

Diameter of high-pressure cylinder	43.31 in.
Diameter of intermediate-pressure cylinder	64.17 "
Diameter of low-pressure cylinder	97 "
Length of stroke	44 "
Average number of revolutions per minute	97

There is one condenser for each set of main engines, with a cooling surface of 8930 square feet, and there are two vertical single-acting air pumps for each set of engines; the cylinders of these are 29.5 in. in diameter. The stroke is 16.73 in., and the speed 164 revolutions per minute. The circulating pumps are driven at the same speed, and have a cylinder diameter of 49.21 in.

Some particulars of the main shafts are annexed:

Diameter of crank-shafts	17.33 in.
Diameter of hole drilled through shaft	7.87 "
Diameter of intermediate shaft	16.93 "
Diameter of hole drilled through shaft	7.87 "
Diameter of screw-shaft	19.29 "
Diameter of hole drilled through screw-shaft	14.17 "
Weight of shafts	84 tons.
Diameter of main connecting-rods	8.85 in. to 8.46 in.
Length of main connecting-rods	88.19 in.

The main engine shafts are in two pieces, one with two cranks, the other with one. The cranks are placed at an angle of 120°. The intermediate shafts are hollow, as stated above, and are provided with clutches, so that either screw-shaft can be disconnected. The screw-shafts pass outside the ship through two cast steel tubes, which are attached at one end to the stern framing, and carried at the other by a steel bracket.

The two screws are of manganese bronze. The test pieces of metal used for these propellers gave the following results:

Ultimate tensile strength	26.67 tons.
Elastic limit	7.62 "
Extension	18 per cent.

The screws have four blades, the diameter being about 19 ft., and the pitch 20 ft. The weight of the two screws is 19 tons.

The hoists through which the ammunition for the 30 and 27-centimeter guns is passed are protected by an armor-plate 12.60 in. thick, which, with the thickness of the hoist tubes, affords a protection of 13.78 in.; the vertical armor of the turrets is 14.57 in. throughout. In the turrets for the 14-centimeter guns this thickness is reduced to 4.72 in. and 3.94 in.

The shelter for the officer in command is elliptical in shape, and it is protected by plates 8.66 in. thick. The 30-centimeter guns can, it is claimed, be fired once every 4½ minutes, the two 27-centimeter guns once every 4 minutes, and the 14-centimeter guns five times per minute and per gun. This is equivalent in the case of broadside firing, and assuming that the 14-centimeter guns are fired continuously at the rate of five rounds per minute to 3 tons of projectiles being thrown every 4½ minutes, without counting the projectiles from the 65, 47 and 37-millimeter guns. The four ammunition hoists serving the quick-firing guns are of steel, and are 1.18 in. thick.

The guns can be trained laterally by hand or by electric motors. The space reserved for manœuvring is sheltered beneath the armored deck above the ammunition stores, but the gun is laid direct from the pointing shelter, where electric switches are placed, connected with the motors under the armor deck. There are two of these motors, of the bi-polar Gramme ring type, driven at the same speed and developing equal power. The operations are controlled by a system of two commutators, one of which is placed in the power room and the other in the shelter within reach of the man training the gun. The former follows the movements of the second absolutely, and delivers current to the rings of the motor; the commutators are so arranged that their directions can be reversed, stopped, or the speeds varied at will. In order to stop the motors very promptly, a condition necessary in this application, they can be changed into powerful brakes by making them discharge into a suitable resistance a current of considerable intensity. The upper commutator, which serves solely to control the lower one, is operated by a very slight current, and its size is reduced as far as possible, so as not to be inconvenient in the limited space within the shelter. Close to the hand of

the operator is a lever that can be moved to the right or the left, and which returns automatically to zero when released. It controls mechanism by which four different speeds can be given to the turret, and which are required when training the gun, to include large angles; the accurate pointing is completed by manœuvring two contacts, one of which moves the gun to the right and the other to the left, the range of motion being controlled by the length of time that the button is depressed. With a little practice the range of movement can be regulated to $\frac{1}{10}°$.

The electric motors are supplied by two distinct circuits, one for the exciting current, the other for the armatures. The former current is always maintained at 70 volts; it is furnished from the lighting dynamos, and remains invariable, whatever may be the speed of rotation. The armatures take a current of 140 volts, or one of 70 volts, the former representing the normal condition of work. With the 70-volt current the speed of the motor is reduced to half. Two special electric installations are devoted to the armament of the ship, independently of the lighting dynamos; they each comprise one horizontal compound engine driving direct two compound dynamos of 500 ampères and 70 volts; these dynamos mounted in series furnish a current of 70 or 140 volts, as may be desired, by means of a special distributor, and in case of either one being damaged it can be cut out of the circuit, one-half the power being sufficient to manœuvre the guns and turrets, though at a reduced speed.

The ship is, of course, lighted throughout by electricity, and the equivalent of 550 ten-candle lamps is found sufficient for all purposes excepting for the Mangin projectors, which are of the 60-centimeter type, and can throw beams of from 1600 to 3000 candles; these projectors are so arranged as to illuminate the sea almost up to the sides of the ship.

CHILI.

BLANCO ENCALADA.

The vessel, which has been built from the designs of Mr. Philip Watts, of the Elswick Works, is of steel, but it is sheathed with wood and coppered. Her principal dimensions are: Length, 370 ft.; breadth, 46 ft. 6 in.; mean draught, 18 ft. 6 in.; and her displacement is 4500 tons. She is provided with a double bottom, and has a steel protective deck extending throughout her whole length, and affording protection to her machinery, magazines, steering gear, etc. This deck has a thickness of 4 in. on the sloping portions at the sides, reduced to $1\frac{3}{4}$ in. on the horizontal parts. The speed trials occupied two days, the first to take place being the natural draught trial, and on a subsequent date the trial with forced draught took place. The machinery consists of two sets of vertical triple-expansion engines of the four cylinder type, and throughout the trials they worked with the greatest smoothness and gave every satisfaction. The natural draught trial lasted for 12 consecutive hours, during the course of which six runs were taken on the measured mile near the mouth of the Tyne. The mean resultant speed with and against the tide on these runs was 21.75 knots, and the indicated horse-power was just over 11,000. On the forced draught trial the mean speed attained on the measured mile with and against the tide was 22.78 knots with 14,500 horses; this speed was more than one-fourth of a knot beyond that guaranteed by the contractors and this notwithstanding that there was a strong wind and considerable sea at the time. It was found that at full speed the vessel could turn through 360 deg. in 3 minutes 47 seconds, making a circle of 405 yards in diameter, thus proving herself to possess admirable manœuvring qualities. All the trials passed off most satisfactorily, and the Chilian Government may be congratulated on the possession of one of the finest, swiftest and most powerful warships of her class afloat.

The gunnery trials of the Blanco Encalada took place on Tuesday, the 22d May. She carries an armament which compares favorably in power with vessels very much larger than herself in the British Navy. Her armament consists of two 8-in. guns, one mounted forward and the other aft, as bow and stern chasers, and ten 6-in. quick-firing guns mounted in sponsons, the two foremost and the two aftermost of which can fire in line of keel. The vessel can therefore direct one 8-in. gun and two 6-in. ahead or astern, and two 8-in. and five 6-in. on any point within 50 deg. either side of the beam. In addition to this armament of heavy guns, she carries 22 smaller quick-firing Hotchkiss guns and five torpedo tubes.

It should be further remarked that the guns composing her main armament are of a peculiarly powerful type. The 8-in. guns are of 40 calibers length, and have a velocity of 2260 ft., with a 210-lb. projectile, and a very moderate chamber pressure. So improved are all the breech mechanism and powder supply arrangements, that the guns may be called quick-firers. This nomenclature was certainly borne out during the trials, when, with a crew that had never fired a round from the gun on any former occasion, four rounds were fired (the powder being supplied from the magazines) in 62 seconds; in fact, the man who has to aim the gun need never be kept waiting for the loading. The 6-in. quick-firing guns are mounted on pedestal mountings; they are also of 40 calibers length, and have a velocity of 2500 foot-seconds, with a 100-lb. shot. During the trials 20 rounds were fired from the 6-in. guns, and eight rounds from the 8-in. Four rounds were also fired from each of the small quick-firing guns. No defect of any kind was experienced.

It should also be mentioned that to thoroughly try the structure of the ship, the after 8-in. gun was fired in line of keel horizontally, and the foremost 8-in. gun was fired ahead with elevation varying from the horizontal 4 deg. for five rounds, four of which were against time. This severe ordeal did not even crack the paint in the decks below the muzzles of the guns, and the only damage reported during the whole of the trials was one broken rail, which had accidentally been left in a position of danger, and a little glass from the chart house.

Before the gunnery trials were undertaken, a torpedo was fired from each of the two port broadside tubes. These tubes are of new Elswick design, and are arranged for the use of cordite impulse, which has given such satisfactory results. A number of experiments has shown that the velocity of impulse of the torpedo is exceedingly regular, and that with a pressure of about 35 lbs. in the tube a velocity of no less than 53 foot-seconds is obtained. The broadside tubes are capable of training through a large arc. During the trials the weather was beautifully clear, and much interest was taken in the long range of the guns when fired at high elevations. The 8-in. guns were fired at 15 deg. elevation, when the shot struck the water at a distance of 10,000 yards, but so clear was the weather that the spray thrown up by the shot was clearly seen each time. So many were the novelties and improvements in the armament of this remarkable vessel, that both the gunnery department and constructive department of the English Admiralty were represented.

REVIEW.

NAVAL BATTLE TACTICS.

By Lieut.-Comdr. R. WAINWRIGHT, U. S. Navy.

A REVIEW OF THE R. U. S. I. PRIZE ESSAY, BY COMMANDER STURDEE, R. N.

In the Prize Essay of the Royal United Service Institution for 1894, Commander Sturdee, R. N., has gone over very thoroughly the principles governing "the tactics best adapted for developing the power of existing ships and weapons (gun, ram and torpedo) which should regulate fleets, groups and single vessels in action." No one interested in naval tactics can fail to read the essay with interest. The arguments are clear and the reasoning generally sound, so that the reader will find his stock of information increased and will enjoy the food for thought, even if he cannot agree with all the conclusions of the prize essayist.

The most important points that are developed in the essay are that the gun is the principal weapon ; that tactics are still of value, and that it is only the unskilful tactician who can see nothing better to do than to charge the enemy ; and that the line ahead is the strongest attack formation.

Even such a skilled torpedoist as Commander Sturdee has been obliged to give the gun the first place as a naval weapon, although he still gives considerable importance to the torpedo, and puts the ram well in the background, as might well be expected of one who in 1886 said: "The fleet should try and pass outside torpedo range, and attack enemy with torpedo-boats." He now says : "Of the three weapons, in my opinion, the *gun* takes the first place, and my reason for giving it that position is primarily on account of its long range, which allows it to become effective long before either of the other two." His conclusion is good, but his reason for arriving at it is not quite sound, as it might be truly answered that with high speed vessels approaching the long range would not be of such overruling importance. He gives 3000 yards as the effective gun-fire range, the opening range, between vessels under way, and 3 minutes as the time between fires for heavy guns. Now, two 15-knot vessels, steering on opposite courses, would approach and pass each other at the rate of a mile every two minutes. So that if the first round was fired at 3000 yards only one more could be fired before the ships had passed each other. The sound reason that places the gun far ahead of the ram or the torpedo is, that you can calculate upon its effect more closely, while under ordinary circumstances the auxiliary weapons depend upon chance for their success. With the uttermost skill the element of uncertainty must enter largely into all calculations as to the probability of damaging an enemy by use of the ram or the torpedo. Whereas the probable injury that may be inflicted by the gun can be calculated with reasonable precision ; and the percentage of hits can be greatly increased by cultivating skilful marksmen. Furthermore, unless you have superior speed, the enemy can prevent the use of the auxiliary weapons and force a combat with the gun.

When the ram was at the height of its favor among naval men, it was held that a bold and skilful commander could easily manœuvre so as to ram a vessel equal to his own if it were commanded by one slightly less skilful than himself; or, if both were of equal skill, the inferior vessel could be easily rammed. Accurate calculations can be made of the tactical diameter under various angles of helm and at different speeds; but slight miscalculations in speed or slight changes made in speed by the enemy, may change the position of the attacking vessel from that of ramming to that of being rammed. The condition of the sea will still further tend to disturb the calculations. It is now pretty generally held that there are too many factors of possible error to allow even the most skilful to count upon success with any degree of certainty, and the penalties of failure are too great to make an attempt to use the ram advisable without some decided advantage is held or has been gained over the enemy, or unless the enemy has superior gun-power or protection, when it would be wiser to use the ram than to run the risk of being overpowered by the guns of the enemy.

Incidentally, Commander Sturdee shows a good reason for the great popularity of the ram, at one time, in the English Navy. Then their battleships were armed with muzzle-loading guns, and owing to the exposure of loaders and spongers to the fire of the guns, their fire would have been kept under at 1000 yards by machine and rapid-fire guns, so that at anything like close quarters, they must have attempted the use of the ram. The Iron Duke class are in that predicament to-day.

Commander Sturdee gives great weight to the torpedo as an auxiliary weapon, he claims that 50 per cent. of hits should be made at the effective range of 450 yards from above-water tubes and allows an additional hundred yards to submerged tubes. I cannot believe that this claim is based on sufficient experience from practical experiments or founded on accurate calculations. Commander Sturdee has had a large experience enough to make any one hesitate to differ with him; but in this case he must have allowed his enthusiasm to alter possibilities into probabilities unless there has been an enormous improvement in the last three years. In the General Information Series No. XI., under the heads of "Naval Manœuvers of 1891" (English), we find that in the Red and Blue Squadrons "eight torpedoes were discharged by torpedo-boats at the enemy, three failed to run, three missed their mark completely, one missed the vessel at which it was aimed, but struck another's net, and the eighth only was successful in hitting its target."* Now this was from torpedo-boats at vessels at anchor; it is hardly possible that the improvement in the weapon and its use is so great as to permit anything like 50 per cent of hits from vessels in motion where the relative speeds of the two vessels must be closely estimated. All this is from above-water tubes; as to submerged tubes but little is known of actual experiments with them, but all naval men know the many difficulties to be encountered in their use and but few have faith in any but the stern tube. In fact the proper place for the development of the torpedo is on the torpedo-boat. It may be continued to be carried on vessels of war, as the necessary installation requires but little sacrifice, weighing little and requiring little space. They may be a source of danger when kept in the tubes ready to fire as they may be exploded by light projectiles, but otherwise their presence on board ship would not be objectionable. Possibly they may be retained on board all vessels of war as is the cutlass.

The second point in the essay grows from the first. The gun being accepted as the principal weapon tactics again become of great importance. We all remember the early English, Dutch and French wars, fought without tactics and consequently without decisive results. Longer range, greater destructive effect and more rapid fire for weight of projectile with greater speed and better handling power to the vessel all serve to increase the value of battle

* General Information Series No. XI., p. 233.

tactics. The more powerful fleet or vessel must lose much of its advantage unless it is handled with the tactical skill necessary to develop its full power.

The adoption of "line ahead" (column of vessels), as the strongest battle formation is rather at variance with other portions of the essay. The group formation has gone for good and needs no argument for its overthrow. When the ram held the position of principal weapon, there were some good reasons for its use, but with the gun as the main weapon, and the ram relegated to the position of auxiliary, there can be no excuse for a formation where so much of the strength of fire is sacrificed as in the case of any of the group formations.

The disadvantages of "line ahead" given in the essay are: "1. Weak right-ahead fire. 2. Difficulty of transmitting signals; 3. Long length of line which is likely to get broken. The first mentioned is the most important, and makes it the worst possible formation, if the attack is to be delivered in the same direction as the length of the column. An examination of the diagrams shows this most clearly. Diagram VII. shows both fleets in column of vessels, here the essayist breaks the R fleet into columns of divisions, so that the leader of B fleet receives an overwhelming fire from R's leading division. That is, if the manœuvre has been completed when about 3000 yards apart, R will have been able to fire about three broadsides from six vessels as well as numerous rounds from the rapid-fire guns upon B's leader. Here R gains the advantage by changing his formation and developing his fire, while B courts disaster by adhering to a faulty formation, a narrow front. The variation where B turns to port is not correctly treated in the essay; for if R reform in column and charge on B, he gives B the advantage of pouring in a broadside fire from most of the fleet on his (R's) leader, and then, if necessary, B can turn in retreat and continue to have the advantage of number of guns bearing. If the gun is the principal weapon, an extended front that develops the fire is as necessary at sea as it is on land, and for a column to attack a line, or the broadside of another column, can only lead to disaster. With the leader of the attack damaged the other fleet need not fear greatly the charge through his line; but to prevent the charge the other fleet only needs to turn in retreat keeping the leaders of the attacking column under the fire of his fleet as long as they pursue, and then turning and assuming the attack when their former pursuers have had enough. Diagram VIII., with the enemy's line abreast, shows the column to be still more faulty. Should B allow R to draw past his right flank, of course R would have the advantage of pouring the broadside of his fleet into B's flank vessel, but should B turn 8 points to the right together, forming in column, R's leader would be subjected to B's broadsides, and B can again turn 8 points to the right together, forming line in retreat, and subject R's leader to the stern fire of his fleet. The first case (Diagram VII.) is the only one in which R would have the advantage, and in this B attacks with a narrow front, R changing his formation so as to extend his fire. Take the remaining two diagrams, enemy in "peletons," or in "divisions line ahead," R in each case gains the advantage by his extended fire, and B loses by his faulty formation.

Column of vessels, "line ahead," when the direction is at right angles to the line of advance of the enemy, gives the most extended fire as long as the enemy advances and the column remains across the line of advance. Should it proceed too far its rear would be exposed, and for attack the formation must be changed. Line abreast admits of an attack with all the vessels, but only with right ahead fire, and the formation must be changed if the enemy threatens either flank. Therefore I believe bow and quarter line to be the best formation, for whichever way the enemy turns you present to him an extended front with the bow fire of all the vessels when advancing, and the stern fire of all the vessels when in retreat, and, with fully developed broadside fire on either flank. This formation can be readily changed into line or into column when manœuvring for an advantage. The difficulty of main-

taining the formation is the most serious objection urged against it. The compass is almost a necessity. We find in the essay that one of the advantages of the column is that "it does not necessitate the use of the compass, which, as Admiral Long points out, may be shot away in action." So many things that may be shot away in action are necessary, that the fewer we are obliged to depend upon, the better. Still, a vessel that is accustomed to sailing in fleet in bow and quarter line, will be able to keep fairly in position when the compass has been shot away.

To sum up, the main conclusions to be drawn from a careful consideration of the subject are: that the gun is the weapon of attack and defense. From all previous experience, and from present knowledge, it is the only reliable weapon. That this is the opinion of the great majority of naval men is conclusively shown by the efforts made to increase the power of the gun and the resistance of armor and the great sacrifices made to carry the necessary weights. This being admitted, it becomes self-evident that the greater the number of guns (caliber remaining the same) the greater the chance of defeating the enemy. The development of the fire of the guns thus becomes important, and therefore the formation and evolution of fleets—naval tactics. Now we see the importance of speed with handiness. Not only do they lend themselves to the prompt performance of evolutions, but superior speed will enable the vessel or fleet to choose their position and gain superiority of fire over the enemy. The battleship must balance and combine the necessary qualities; while inferiority of speed may allow of superiority in guns, the low speed may result in real inferiority in gun power because of the superior facility with which the more speedy vessel can be handled.

The many points of the essay are too numerous to admit of all of them being reviewed; but they all emphasize the author's motto: "In war it is not permitted to err twice." The skilful treatment of the subject is not only a lesson in itself, but it also illustrates the necessity of making a study of Naval Tactics.

BOOK NOTICES.

ELEMENTARY NAVAL TACTICS. By Commander Wm. Bainbridge-Hoff, U. S. Navy. New York: John Wiley & Sons, 1894.

This little book is a revision of "Examples, Conclusions and Maxims of Modern Naval Tactics," published several years ago by Commander Hoff, and brings the question of naval tactics up to date. It is the expression of the most advanced theories upon the conduct of ships and fleets in action, and although it is intended as a text-book and called elementary, it will undoubtedly be received as a contribution of substantial value to the meagre literature of naval tactics and strategy.

The main subject is treated under four general heads: the Ship in Action, the Organization of the Fleet, and the Fleet in Drill and in Action. The text is elucidated by admirable diagrams, which are not unnecessarily encumbered with lines and figures.

Commander Hoff does not tell us much that we have not been told before, but his pages teem with facts that cannot be repeated too often, and that deserve to be studied and remembered.

In the discussion of the Ship in Action the writer says: "Secondary fire should be opened on the enemy as soon as possible. It can begin for the 6-pounders at a distance of 3000 yards, and for the larger calibers of the secondary battery at about 2000 yards. Machine gun fire of small caliber and small-arm fire are available at 1500 yards. The great-gun fire of the ship has its greatest weight inside of 1200 yards." This is a generally accepted proposition, but there is excellent reason to doubt that in future naval battles heavy-gun fire will be reserved for such close distances, when we have powerful guns of large caliber accurately ranged to 8000, 10,000 and 12,000 yards. A ship of great speed will probably choose her own distance, and under some circumstances lay off beyond range of the secondary battery and use her great-gun fire with effect. Certainly when it is in her power to avoid it, she will not expose her personnel to the withering hail of bullets from machine guns and small-arms. If, however, the two combatants bear down on each other *end on*, great speed must be maintained to minimize the chance of being hit by shot or torpedo, "then when the enemy has passed by, you need the greatest speed to get out of the range of his most aggressive fire, to turn quickly and get back at him, and strive to enter his turning circle, where you will be safe from any possibility of his ramming you."

In regard to the use of rams in ship duels, Commander Hoff says: "Where the speeds are different, but the turning circles equal in diameter, the faster ship can always ram the slower." On the other hand, a recognized authority on naval matters has recently declared, that "to endeavor to effectively ram a ship that has sea-room and that is under control is hopeless, even if she be of greatly inferior speed." The varying circumstances of a sea fight do not permit hard and fast rules, although it is true that every encounter is governed by certain general principles.

Concerning fleet actions, the position of the commander-in-chief and the formation for attack are discussed at length. Commander Hoff thinks the flagship should be the best and fastest protected cruiser, and gives good

reasons for his faith. Many other tacticians, however, insist that the admiral should lead the attack in his heaviest and most formidable battleship. These vexing questions, like many similar ones, will never be settled except by actual experience.

No definite battle formation is recommended, but we are told that the force should enter the attack in the following order:

1. Bow fire ships with good ramming power.
2. Broadside ships.
3. Ram,

and are then reminded that all fighting formations come within one of the four following categories:

1. Narrow front—great depth. (Column.)
2. Extended front—slight depth. (Line.)
3. Front and depth equal. (Square.)
4. Groups.

When we have trustworthy reports from the battle of the Yalu, and learn how the Japanese fleet engaged, whether in column (concentrating on a particular point of the enemy) or in line, much light may be thrown on this important question, even if we obtain nothing conclusive.

Melées which were once accepted as inevitable under modern conditions, are deprecated. If, however, the formation disappears, then each ship is to hold on to her mate and work with her. Indeed, all the authorities agree that the ships of the fleet must be paired, and under all circumstances the leader and mate must mutually support each other, with the single purpose of loyalty to the plans of the commander-in-chief.

It may surprise many to know that the despised spar-torpedo has not outlived its usefulness, that it still has an important part to play, and "must not be omitted from the factors of war."

"In the melée the spar torpedo-boat would have an advantage over the automobile torpedo-boat, as the latter would be afraid to use her torpedo, since an enemy missed might mean a friend destroyed." "Spar-torpedoes are best used on a dark night and with the water a little rough, in the midst of strong currents and against vessels strongly defended with obstacles."

Two terms appear in the book that will perhaps be new to the majority of its readers—namely, Sea-Army and Sea-March. The first is applied to that heterogeneous collection of war-ships, supply vessels, floating repair-shops, floating hospitals, telegraph ships, tugs, etc., and all the necessary accompaniments which go to make up the *impedimenta* of the *fin de siècle* fleet for offense and defense. The progress of this armed force and its non-combatant convoy is termed the sea-march.

In brief, this book will commend itself to every student of naval affairs, and Commander Hoff is to be congratulated upon the result of his study and the skill with which he has put his material together. We venture to predict a ready acceptance of his book at home and abroad. A. G.

HANDBOOK OF THE SIX-POUNDER HOTCHKISS RAPID-FIRING GUN, American Model of 1894.

In addition to the nomenclature of the various parts and accessories, together with a complete description of the gun, action of mechanism and the directions for mounting and dismounting, this pamphlet contains the gun drill, instructions in judging distance, a sighting and aiming drill, instructions for target firing, care and cleaning and the range table for the particular gun, L/45. The accompanying illustrations are complete in every particular. The gun is presented to us with no unnecessary verbiage, in a clear, attractive and thoroughly instructive way.

HANDBOOK OF THE ONE-POUNDER HOTCHKISS RAPID-FIRING GUN, American Model of 1894.

Much of what was said of the Handbook of the Six-Pounder is applicable to this. It contains, in addition, a description of the field mount and drill, and a boat drill for the gun either on field carriage or special boat mount. The handbook is thorough, and is remarkable for its simplicity, nothing unnecessary being inserted.

INDIANLAND AND WONDERLAND. By Olin D. Wheeler.

This brochure is issued by the Northern Pacific Railroad Co. The device is adopted of keeping the company and railroad in the back ground, and presenting striking descriptions and beautiful illustrations of people, places and scenery (all of which, be it remarked, may be reached by the route in question). The booklet is very neatly gotten up and will well repay perusal by the prospective tourist.

ELECTRIC LIGHTING PLANTS; THEIR COST AND OPERATION. By W. J. Buckley. Wm. Johnson Printing Co., Chicago, Ill.

The author presents his subject from the point of view of the salesman, and furnishes an array of facts and figures that cannot be otherwise than useful to an intending buyer. In a desire to be deserving of his salary, as he says, the author mentions no other company than his own—the Wood. Books issued in this way are not always free from suspicion, but most of the statements, directions and rules herein are entirely independent of companies, and are interesting to all who have to do with electric lighting plants.

ELEMENTS OF ELASTIC STRENGTH OF GUNS. A Text Book for the Use of Student Officers at the U. S. Artillery School. By Captain John P. Story, Fourth Artillery, U. S. Army. Artillery School Press, Fort Monroe, Va.

Certainly Captain Story is to be congratulated upon this book, which is thoroughly well, carefully and conscientiously done from beginning to end. Probably no subject has in the past been more variously handled than this same; the methods used have often been intricate, round-about and exceedingly mixed, though the results of the long systems of unraveling employed undoubtedly were and are correct. The subject is in reality an easy one to understand but exceedingly difficult to explain. The author follows the Method of Strains of Clavarino, as modified by Captain Birnie, of the U. S. Army; the longitudinal stress is regarded as zero. The safe pressure that a gun can stand calculated on this assumption is very safe, being lower than that found by the direct use of Clavarino's formulæ.

Captain Story's methods are exact, his mathematics generally above reproach (he is very copious with his formulæ, intending, no doubt, to cover every case), and his language is clear and connected. If anything is lacking it is nothing more than a brief summary at the end, the fine points being somewhat obscured by the very completeness of the book.

Among the original methods in this book, the best in the mind of the reviewer is the handling of the subject of shrinkage. Briefly, the method is this: The shrinkage is equal to the compression of the outer diameter of the inner tube plus the extension of the inner diameter of the outer tube (jacket or hoop). [The changes from the dimensions of the unassembled parts are referred to.] This, of course, is not new, but the application is. Add to the above statement *under any circumstances*, suppose the gun in action (or at rest), and we have the method. The pressures at the surfaces of the various cylinders when the gun is in action (or at rest) are known. Calculate the extension of the inner diameter of the outer tube due to the

pressures on this tube and of the outer diameter of the inner tube due to the pressures on this inner tube. The sum is the shrinkage. All this is new, easy, ingenious, the direct method hitherto undiscovered, so far as we know. After looking at it, the wonder is that we did not see it before. Certainly it is remarkably simple comparatively with the literature of shrinkage to date; and it requires little thought and no demonstration to see that it is strictly true (the compression or extension under stress of so short a length as the shrinkage itself being neglected). Of course, if the outer diameter of the inner tube is really extended in any case beyond what it was before assembling, its compression must be regarded as negative.

A method using the pressures in the gun at rest has already been described and used by the ordnance department of the army. An equivalent method discovered quite independently and without knowledge of the existence of this last has been used in section rooms at the Naval Academy. Both are special and are included in Captain Story's method, which is perfectly general and is true for the gun at rest or in action, or at any intermediate stage. The easiest and most direct method is with the gun in action.

There are numerous other good points to the book; for example, a formula is given which shows the elastic strength on the condition that the inner tube of a built up gun is not deformed when the gun is at rest. This formula is not given in any previous text book. It does not however cover such a difficult matter as shrinkage, the subject being already clear and well understood. Though the author does not mention it, we cannot but call the attention of those interested in wire-wound guns to this formula.

In the figure representing the two pressures on his elementary tube (Fig. 3), Captain Story has pointed the arrows representing the stresses or forces p and $p + dp$ in the same direction. These two stresses exist of course, but, as the author well knows, equal and opposite forces exist at the same points, and it will be a little confusing to a beginner to understand the accompanying demonstration because the two arrows shown are not what might be called corresponding. Both should represent either the hold-back stresses of the tube, or else the stresses applied from the interior and exterior respectively. In regard to the handling of the linear differential equation on the next page, in which the author separates the variables and integrates, the use of an integrating factor would be more direct. Both ways of course are laid down in works on differential equations. This, however, is a minor point.

The author's notation is new and simple, and as we understand that he is willing to allow its employment by all (it is covered by copyright) provided that due credit is given to himself, it will probably have a very general use in the future. It is a pity that only a small edition of this little book has been printed by the Government, as it certainly deserves well and should be accorded a hearty reception.

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An experiment was made by securing a piece of 12-oz. duck over the end of a 4-in. pipe.

With a pressure of 1 lb. per square inch the canvas showed no signs of any water coming through.

Pressure 2 lbs.: water came through pores in rapid drops, rapid pumping being required to keep up pressure.

Pressure 5 lbs.: water came through so fast that the pump maintained the pressure with the greatest difficulty.

A couple of handfuls of mud were next placed in the pipe, which was well shaken. Pressure was then applied with results as follows:

Pressure 2½ lbs.: canvas perfectly water-tight. (This corresponds to a distance of about 2 times 2½ or 5 feet below the surface of a body of water.)

Pressure 5 lbs.: slight drip in a few places, water coming through clear; 7½ lbs., same as with 5, a little more leakage; 10 lbs., still more leakage, but not large; 50 lbs., water still comes through clear. The canvas was still unruptured, supporting a pressure on a circle of 4½ inches diameter of about 800 lbs. without tearing.

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As only about 40 minutes are required for each determination it is evidently the quickest working calorimeter that has ever been invented.

The Pneumatic Pyrometer.

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JUNE 16. Agordat (continued). Instructions for Engine-Room Logs in German Navy. Local Organization of England's Squadrons and Naval Stations.

This article enumerates the military bases and coaling stations of Great Britain at home and abroad:

1. The Home Station comprises the eastern part of the Atlantic to the Canary Islands and the North Sea; the principal base is Portsmouth, further fortified harbors and coaling stations are Chatham, Sheerness, Portland, Devonport, Pembroke and Queenstown.

2. Mediterranean and Red Sea Station: The principal base is Malta, with strong fortifications of La Valette. Controlling points and coaling stations are Gibraltar, Perim Island in the Straits of Bab-el-Mandeb commanding the entrance to Red Sea, and Aden.

3. East Indies: Principal base at Trincomale. Fortified coaling stations: Bombay, Colombo, and Port Louis in Mauritius.

4. The China Station comprises the China Sea and northwestern part of the Pacific Ocean together with the Sandwich Islands. Main base is Hong Kong, entrances protected by batteries. Fortified harbors and coaling stations at Singapore and Labuan.

5. Australian Station comprises the southwestern part of the Pacific ocean, Australian waters and Sunda archipelago. Main base is Sydney, one of the safest and largest harbors in the world, protected by Forts Macquaril, Philipp and Denison. Coaling stations at Melbourne and Wellington.

6. The Pacific Station comprises the eastern part of the Pacific ocean along the west coast of America. Main base and coaling station is Esquimault.

7. South-East Coast of America: Main base is Port Stanley on the northeast coast of East Falkland Island.

8. North American and West India Station comprises the northwest part of the Atlantic ocean, the Gulf of Mexico and Caribbean sea. Main base is Halifax, protected by a high citadel and Fort Charlotte. Fortified harbors and coaling stations at Bermuda and Port Castris in St. Lucia Island.

9. Cape of Good Hope and West Coast of Africa comprises eastern half of South Atlantic ocean from the Canaries south. Main base at Cape Town. Fortified harbors and coaling stations at Simonstown in False Bay, St. Helena, Ascension Island, and Freetown in Sierra Leone.

All cruising vessels are comprised in eleven squadrons, three of which, the Channel, the Training and the Coast defense squadrons, are on the Home Station, the remaining eight being assigned to the above mentioned stations.

The Channel squadron has 8 vessels, the Training and Coast Defense squadrons 4 and 9 respectively, Mediterranean 26, East India 9, China 18, Australia 14, Pacific 8, South America 4, North America and West Indies 11, Cape of Good Hope 12; total, 123 vessels—comprising 25 armored battleships and 54 cruisers of different sizes.

The Mediterranean fleet contains 11 battleships, first-class, and 7 modern

cruisers. Besides, there are 6 old-time armored battleships as station vessels, viz.: 2 in the Bermudas, 2 in Bombay, 1 in Hong Kong, 1 in Melbourne. Twenty-six thousand men man these vessels. The majority of the vessels not in commission are laid up in Sheerness, Portsmouth, Devonport and Queenstown.

JUNE 20. Agordat (concluded). Defenses of Corsica.

Report of Lockroy on the proposed fortification of Corsica. He urges the establishment of a war-base at Porto Vecchio; the harbor could acommodate 11 battleships and 12 cruisers. The necessary dredgings would cost 3½ million francs. In addition, various fortifications to be erected along the coast, at Bonifacio, batteries on the salient promontories. A supply depot on the southern end of the island. Besides, in order that France may be able to sustain the Toulon-Porto Vecchio-Biserta line in opposition to the Gibraltar-Suez line, steps must be taken for systematic organization of the defenses of Biserta. Mr. Lockroy urges the strategic importance of Corsica as a link between France and its North African possession, points out the necessity of improving its harbors, strengthening the island all along its southern coast, especially as Italy is at work energetically in making La Maddalena into a seafort of first importance.

JUNE 23. The Coast Defenses of France.

Extracts from Traité d'Artillerie à l'Usage des Officiers de Marine, par Ernest Nicol, lieutenant de vaisseau.

JUNE 27. Military Lessons Gained by Examples in Modern Military History. Imperial Ordinance for the Protection of Carrier Pigeons and Pigeon Service in War.

JUNE 30. Experiments in Russian Army with the French Step. Battleship for Japan.

JULY 4. Launch of the Caprera. Torpedo-Boat Practice at Newport.

JULY 7. The Increase of the French Navy. Accident with French Field Piece. Launch of the Russian Battleship Sissoi Weliky and Trial Trip of the Petersbourg.

JULY 11. Experiments in France on the Visibilities of Different Colors. List of Japan's Men-of-War. H. G. D.

ENGINEER.

No. 2005, JUNE 1, 1894. Gunnery Trials of the Chilian Cruiser Blanco Encalada. Warships and Critics.

JUNE 8. The Russian Volunteer Fleet (illustrated). The Indiana Armor Plates (letter).

JUNE 15. The Torpedo-Destroyer Hornet. Speed Trials of the Chilian Cruiser Blanco Encalada. Maxim's Cuirass Competition (illustrated). Six German Steam Boiler Experiments with the Same Coal.

JUNE 22. Engineering Works of Messrs. Yarrow & Co. (illustrated).

JUNE 29. The Fastest Ship in the World.

The British torpedo-catcher Daring made a mean speed of 28.6 knots in three runs over the measured mile.

The Comparative Results of Certain Steamship Trials (letter).

JULY 6. The Maritime Section of the Antwerp Exhibition. The Majestic and Magnificent. New Russian Steel Shot.

JULY 13. A New Incandescent Light.

JULY 20. H. M. S. Ferret. The Cordite Appeal. Bethlehem Armor Plates.

JULY 27. Launch of H. M. S. Eclipse. A Combined Ammeter and Voltmeter (illustrated).

AUGUST 3. International Navigation Congress. Russian Secret Process Shot. Design of Mail Steamers with Special Reference to their Use for War Purposes.

AUGUST 10. The Minneapolis. Sixth International Congress on Inland Navigation. The Marine Boiler of the Future. American Armor. Design of Mail Steamers, etc. (continued).

AUGUST 17. Weldless Rolled Chains; the Klatte Process. Design of Mail Steamers, etc. (concluded).

AUGUST 24. Torpedo-Boat and Shipbuilding in France. Hadfield's Projectiles for Treated Plates.

AUGUST 31. Engines of H. M. S. Daring and Decoy. Loris' Bullet and Dagger-Proof Cuirass.

ENGINEERING.

VOLUME LVII., No. 1481, MAY 18, 1894. Krupp Ordnance (illustrated). The Crampton-Smith Position Finder (illustrated).

This is somewhat similar to the Fiske, working electrically, two beams of light parallel to the sighting telescopes being thrown on a chart by means of two inclined mirrors.

The New Spanish Belted Cruisers (illustrated). The French Ironclad Jauréguiberry (illustrated).

All firing and turret manœuvres on the Jauréguiberry will be executed by electricity or by hand.

MAY 25. Krupp Ordnance (illustrated). Steam Trials of H. M. S. Hermione.

JUNE 1. The New Spanish Belted Cruisers (illustrated). Gunnery Trials of the Chilian Cruiser Blanco Encalada.

JUNE 8. The Fletcher Rapid-Firing Gun (illustrated).

JUNE 22. The New Spanish Belted Cruisers (illustrated).

JUNE 29. The New Thornycroft Torpedo Vessels.

JULY 6. The New Spanish Belted Cruisers (illustrated). The Buffington-Crozier Disappearing Gun Carriage (illustrated).

JULY 13. The Vibrations of Steamships. The Action of Screw Propellers (illustrated). Launches and Trial Trips.

JULY 20. Steam Boiler Experiments (illustrated). The Seabury Breech Mechanism (illustrated). Light Tower at Cape Charles, Virginia (illustrated). The Blanco Encalada (illustrated). The Amplitude of Rolling on a Non-Synchronous Wave.

JULY 27. The Institution of Naval Architects (summer meeting).

AUGUST 3. The Institution of Naval Architects (summer meeting). The United States Protected Cruiser Olympia (illustrated). Electric Welding (illustrated).

AUGUST 10. The Maxim Flying Machine (illustrated). The Portents of Marine Construction. The Vibrations of Steamships.

AUGUST 17. The Admiralty and its Contractors.

AUGUST 24. Guns and Mountings of the Spanish Belted Cruisers.

JOURNAL AND PROCEEDINGS OF THE UNITED SERVICE INSTITUTION OF NEW SOUTH WALES.

VOLUME V., 1893. A New Dial for Indicating Ranges in Coast Defense. Modern Coast Defense. Infantry Attack Formations and Fire Discipline. The Military Art of the Romans, as Illustrated by the Wars of Cæsar.

JOURNAL OF THE ROYAL UNITED SERVICE INSTITUTION.

MAY, 1894. The Tactics Best Adapted for Developing the Power of Existing Ships and Weapons (Gun, Ram and Torpedo) which Should Regulate Fleets, Groups and Single Vessels in Action (special mention).

JUNE. Some Aspects of Coast Defense. The Art of Breathing as Applied to Physical Development.

JULY. The Firing Line and How to Keep it Organically Subdivided to the Last A Study of War Navies (translation). Torpedo-Boats in Fleet Actions (translation). The Moral Element in Strategical Science of the Nineteenth Century.

AUGUST. Attack or Defense Strategically and Tactically Considered. J. H. G.

MILITÄR-WOCHENBLATT.

No 38, May 5, 1894. The Causes of the Victories and Defeats in the War of 1870. The Field Piece of the Future (continued).

May 9. The Field Piece of the Future (concluded). Caliber Reduction.

The continued reduction of caliber is not confined to small-arms and field pieces. It has been applied to the heaviest guns destined for naval uses. It is a remarkable coincidence that from England and France nearly simultaneous reports come of proposed reductions in calibers of their heaviest ordnance. In England the 110-ton and 68-ton guns are to be replaced by 50-ton guns; and in France the 42-cm. gun is to be replaced by 34-cm. guns.

May 13. Annual Report of Swiss Military Department, 1893. 6.5 mm. Mauser Magazine Rifle for Swedish Army.

May 16. Penetrative Power of French Lebel Rifle. R. F. Guns in Congo State.

May 20. Reorganization of the Military School at St. Cyr.

May 23 and 27. Drill Regulations for Cavalry (I., II., III. and IV.). Hygienic Soles for German Army.

May 30. Military Readiness of Swiss Army. Changes in Battle Tactics of French Infantry. Bird's Eye View of Rules, Instructions and Exercises of French Cavalry Service.

June 2. The Two-Fold Increase of the Sixth French Army Corps. The Military Readiness of the Swiss Army (continued). The Engagement Between the Independencia and the Andes on 29th September, 1893 (with sketch).

June 6, 9, 13. The Military Readiness of the Swiss Army (concluded). The First (Royal) Dragoons. The Cavalry School at Saumen.

June 16. Firing Trials of English Field Artillery. Reorganization of the Paris Polytechnic School. Launch of the Caprera.

June 20. Digest of Drill Regulations for Cavalry. Acceptance of the Capitan Prat. French Rapid-Fire Guns.

Of the rapid-fire guns for the Navy the 16-centimeter gun until recently was the only one in which the shell and powder charge were separated, being *fixed* in the smaller calibers. It is now determined, on account of easier stowage and transportation, to separate shell and powder charge of the 14-centimeter gun. The fixed stand for this gun was 51 inches long, weighing 97½ lbs. The rapidity of fire with the fixed ammunition was about 6 shots per minute; it was found that the rapidity of fire is but slightly diminished by loading shell and powder separately.

June 23. Reduction in Rounds per Man in German Army. Naval Estimates of the United States, 1894–95. New Spanish Rapid-Fire Gun.

This new gun is the invention of Lieutenant Ordoñez. It is a steel 12-centimeter rapid-fire gun, consisting of a tube, jacket and rapid-fire breech mechanism, the former each of one forging. The ammunition to include four kinds of projectiles, viz.: battering shell, common shell, shrapnel and case, each weighing 25 kilograms. According to Gâvre formula the muzzle-velocity will be 2362 feet per second, with a charge of 7 kilograms of smokeless powder, giving a pressure of 1877 kilograms per square centimeter. The gun has a length of 45 calibers. The gun factory at Trubia will construct the gun.

JUNE 27. New Russian War Vessels.

JUNE 30 AND JULY 4. Digest of Drill Regulations for Cavalry. Field Artillery in Manœuvres and in War. The English Naval Budget for 1894 to 1895. New Japanese Armor-Clads.

Up to the present, France furnished most of the cruisers to Japan, excepting some very fast ones built by Armstrong. Japan has ordered two large battleships, each of 12,250 tons from English firms. One to be built by Armstrong, Mitchell & Co., at Elswick; the other, the Fusiyama, by the Thames Shipbuilding Company. They are very much like the English battleship Renown. Length to be 370 feet, beam 72 feet, depth 26 feet. The armor belt to be 223 feet long, and 16 to 18 inches thick, the armor of turrets 14 inches and the protective deck 2½ inches. They will carry four 12-inch 50-ton guns, two in each turret, and thirty-four rapid-fire guns, viz.: ten 6-inch, fourteen 3-pdrs., and ten smaller; also six torpedo-launching tubes. The engines of 14,000 horse-power, to give a speed of 18 knots. Coal capacity is 700 tons, may carry 1100 tons however. The ships are fitted with two military masts and carry two torpedo-boats. To be finished in 1898.

JULY 7 AND 11. English Naval Budget, 1894–95 (continued). Military Notices from Russia.

JULY 14 AND 18. Tactics of the Future. English Naval Budget 1894–95 (concluded). Russian Summer Manœuvres. Expenses of French Army and Navy Maintenance.

MITTHEILUNGEN AUS DEM GEBIETE DES SEEWESENS.

VOLUME XXII., No. 6. Electric Search-Lights at Sea. Electric Motors for Guns and Ammunition Hoists. The English Torpedo-Boat Destroyer Hornet. The New French Battleships Charlemagne and Saint Louis. Torpedo-Boat System and Mobilized Coast Defenses of France. Instructions for Draining Steam Pipes on Board German War Vessels. Estimates for the Imperial German Navy, 1894 to 1895. Ships of the Royal Sovereign Class. On Closing Water-Tight Doors on Men-of-War. English Trials with Wire-Rope Barricades. Armament for English Auxiliary Cruisers. Launch of the Halcyon. Building Programme for English Fleet. The Japanese Cruiser Tatsuta. The Two Russian Torpedo-Boats. Rapid-Fire Guns of Large Caliber.

No. 7. The Nautical Instruments of Joseph Resselo. Electric Motors for Guns and Ammunition Hoists (concluded). Toulon

and the Mediterranean Fleet. Tables for Simplifying the Calculations of Noon and Midnight Corrections. The English Navy. The Italian Navy. United States Navy. Spanish Men-of-War. Contracts for New English Battleships. The 42 English Torpedo-Boat Destroyers. The Campania and Lucania. Tests of Cordite. Zalinski's Pneumatic Guns. Gun Trials in the United States. The English Twin-Screw Steamer Torr Head. Deplorable Wiring Aboard Ships. On Determination of Economic Speeds.

H. G. D.

LE MONITEUR DE LA FLOTTE.

Nos. 18 and 19, May 5, 1894. The Naval Estimates for 1895. List of the Personnel: Increase and Diminution of Its Effective Strength. Squadrons and Divisions. Mobile Defenses.

May 19. Battleships and Cruisers (5th Article).

May 26. The English Admiralty.

June 9. Designs of Vessels in England. Our New Constructions.

June 23. About the Fire of Coast Batteries. The Navy in Parliament. The Law of the List of the Personnel.

June 30. The Navy in Parliament: Reductions in the Navy Budget.

July 7. The Lowering of the Age of Retirement. The Naval Manœuvres.

July 14. Apropos of Pilots. The Fire in the Toulon Dock Yards.

July 21. The Naval Manœuvres.

July 28. Apropos of the English Naval Manœuvres.

August 25. Contraband of War. China and Japan. J. L.

PROCEEDINGS OF THE ROYAL ARTILLERY INSTITUTION.

May, 1894. The Brome-Walton Family; Chap. V. The New Firing Manual of the German Field Artillery.

July. What is the Best Tactical Organization and System of Training Massed Batteries of Horse and Field Artillery (Prize and Commended Essays)? J. H. G.

REVISTA DEL CLUB MILITAR.

2d Epoca, No. 1. Field Artillery. Episodes in the History of the Argentine Republic. Model of the Argentine Mauser.

REVISTA TECNOLÓGICO INDUSTRIAL.

APRIL, MAY, JUNE, JULY, AUGUST, 1894. Causes of Explosions in Steam Generators. Principles of Cotton Carding and Carding Machines.

REVUE DU CERCLE MILITAIRE.

No. 18, MAY 6, 1894. The Irregular Troops of the Chinese Army: The Braves (continued). The Battery Step-Ladder.

MAY 13. The Compass-Guide, for Infantry on the March (with sketch). The Irregular Troops of the Chinese Army: The Braves.

MAY 20. The Hemerograph of Commandant Blain.

This is an entirely new instrument, having all the applications of the camera lucida without any of its drawbacks. It permits, moreover, of the reproduction of images and objects, and in war time would prove an indispensable help to an officer in the field, as he could make in a few minutes a most accurate sketch of his surroundings. A full description of the instrument is given.

Nos. 24, 25, 26. Our Colonies. The Buffer State of the Mekong. The Borders of the Cameroon.

JULY 8. The R. F. Cannon. Experiments in Roumania with Smokeless Powder.

JULY 15. The R. F. Cannon (continued). Our Colonies: The Congo and the Nile (continued). See Nos. 24, 25 and 26 of the Review with the Map of No. 27.

JULY 22. The R. F. Cannon.

JULY 29. The Chinese Navy. The Military and Naval Forces of Japan. The Italian School of War.

AUGUST 5. Marches and Manœuvres in the Alps. New Organization of the Service of Cavalry Remount in Germany. The Italian School of War (ended).

AUGUST 12. Marches and Manœuvres in the Alps. New Organization of the Service of Cavalry Remount in Germany. The Italian War Estimates.

Nos. 33 and 34. Gun versus Armor.

SEPTEMBER 2. German Criticisms of Our New Infantry Regulations. The Fortress Manœuvres.

SEPTEMBER 9. The Workings of the Maxim Flying Machine.

REVUE MARITIME ET COLONIALE.

MAY, 1894. Naphtha and the Torpedo-Boat 104 S (from the Italian). Influence of Naval Power on History (1660–1783), by Capt. Mahan, U. S. N. Maritime Fishery.

JUNE. Geometry of Diagrams. Economic Questions on the Indicator Curves. Influence of Naval Power on History (1660–1783), by Capt. Mahan, U. S. N. The Port of La Seyne and its Maritime District. Statistics of Shipwrecks and Other Sea Mishaps for the Year 1892.

JULY. Influence of Naval Power Upon History (1660–1783) (continued), by Capt. Mahan, U. S. N. The War in Paraguay. Vocabulary of Powders and Explosives (continued). Statistics of Shipwrecks and Other Sea Mishaps for the Year 1892.

AUGUST. Geographical, Topographical and Statistical Notes on Dahomey (3d, 4th and 5th Parts). A Study of the Compasses of the Cruiser Dubourdieu, During a Two Years' Cruise in the Pacific (1891–1893), by Lieut. Mottez, of the French Navy. Influence of Naval Power on History (1660–1783) (continued), by Capt. Mahan, U. S. N. Long Aerial Voyages. "Aerostats" and the Crossing of Southern Africa.

RIVISTA DI ARTIGLIERIA E GENIO.

VOLUME II., MAY, 1894. Notes on Elastic Deformation and Resistance of Materials. About the Regroupment of Guns in Field Batteries. The New Drill and Interior Service Regulations for Artillery. Observations and Suggestions Touching Field Intrenchments and Intrenching Implements. Automatic Land Torpedoes.

JUNE. Notes on Elastic Deformation and Resistance of Materials.

REVISTA MARITTIMA.

PART V. (WITH SUPPLEMENT), MAY, 1894. Naval Strategy. About Electric Ventilators. The Torpedo-Boat in Squadron Engagements. Resistance to Motion of Ship.

JUNE. Considerations of the First Theme of the Italian Naval Manœuvres. Premiums in Our Merchant Marine.

JULY (SUPPLEMENT). Considerations of the First Theme of the Italian Naval Manœuvres. The Fiske Telegoniometer; Some Late Experiments. Modern Evolutions of the Pleasure Boat. Recent Improvements in Marine Engines.

AUGUST AND SEPTEMBER. Water-Tube Boilers. Considerations of the First Theme of the Italian Naval Manœuvres. Inflammable Mixtures: The Origin of Powder, and the First Pieces of Ordnance.

SOCIÉTIÉ DES INGÉNIEURS CIVILS.

MARCH, 1894. A Study of the Changes in the German Principal Railway Stations. Computation of Cement Works with Metallic Frames.

APRIL. The Canadian Pacific Railway.

MAY. Locomotives of Complete Adhesion for Curves of Small Radius.

JUNE. Of the Origins of Atmospheric and Marine Currents, Theory and Apparatus of Mgr. Rougerie: Preponderant Influence of the Earth's Rotation, by Baudon de Mony.

Mgr. Rougerie, the learned Bishop of Pamiers, has found in the rotation of the globe combined with its movement of translation and solar heat, the real causes of the atmospheric and marine currents, and in order to prove this by actual experiment, he built apparatus by means of which he was able to produce currents similar to those in nature.

JULY. A New System of Fumivorous (Smoke Consuming) Furnaces, Applied to Manufactures, Fireplaces or Kitchen Ranges.

J. L.

STEAMSHIP.

JULY, 1894. Water-Tube Boilers in the Navy. Combined Ammeter and Voltmeter.

AUGUST. Auxiliary Machinery of a Modern Cruiser. Importance of Fuel in Very Fast Vessels. Mail Steamers and their Use for War Purposes.

UNITED SERVICE GAZETTE.

MAY 12, 1894. French Operations in the Soudan. The Present Naval Position.

MAY 19. An Improved System of Signaling. The Next Naval Battle. Service Signaling.

MAY 26. A Bullet-Proof Cloth Cuirass. Banquet to the Officers of the United States Navy. Our American Naval Cousins.

JUNE 2. Reorganization of the Swiss Army, I. A Year's Hydrographic Work.

JUNE 9. The French Navy. Reorganization of the Swiss Army, II. The Gun, the Torpedo and the Ram, I.

JUNE 16. The Differentiation of Naval Force. H. M. S. Hornet. The Gun, the Torpedo and the Ram, II.

JUNE 23. The French Navy, II. The Gun, the Torpedo and the Ram, III.

JUNE 30. Imperial Maritime Defense.

JULY 7. A Compass Steering Invention. Armor Plate Trials. Naval Defense.

JULY 14. The Protection of Commerce in War.

JULY 21. The Naval Manœuvres, 1894 ; General Orders, Fleets, Chart. The New Spanish Cruisers. Armor Plate Trials in Russia. The Forthcoming Naval Manœuvres.

JULY 28. Coal Consumption.

AUGUST 4. The Strength of the British Fleet as Compared with the Fleets of France and Russia. The Naval Manœuvres. The Royal Navy and the Mercantile Marine.

AUGUST 11. The Naval Manœuvres. The Recent Naval Manœuvres ; their Significance.

AUGUST 18. The Recent Naval Manœuvres ; their Teaching.

AUGUST 25. The Composition of Fleets. J. H. G.

LE YACHT.

No. 843, MAY 5, 1894. The Navy Board of Estimates and Enquiry. Apparent Gravitation, Apparent Vertical, and Sea Sickness.

MAY 19. The German Navy Budget. Yachting in England.

MAY 26. Evidence Produced Before the Navy Board of Inquiry in Regard to the Magenta. The English First-Class Battleship Hood.

JUNE 2. Our New Constructions in 1895. Chronicles of the English Races. Lord Brassey's Naval Annual.

JUNE 16. Foreign Navies: England, Russia, United States, Japan, Chili. The Japanese Cruiser Yoshino. The Sailing Registering-Compass of Lieut. Bersier.

JUNE 23. Report of Admiral Vallon on the Magenta. Habitability of Boats Made of Aluminum.

JUNE 30. Japan's Dock-Yards and Ours (French). The New Torpedo-Destroyers Havock and Hornet.

JULY 7. Apropos of the Magenta. The Spanish Armored Cruiser Infanta Maria Teresa.

JULY 21. Manœuvres of the North Squadron. Steam Service Between Dieppe and New Haven. The Seagoing Torpedo-Boat Chevalier. Chronicles of the English Races. R. F. Cannon and Protection of Superstructures (continued).

JULY 28. The English Naval Manœuvres. The Torpedo-Boat Chevalier. A. Normand's System for Lessening Vibration in Light

Built Vessels. Naval Manœuvres in the Channel. Electricity: Accumulators. R. F. Cannon and Protection of Upper Works (Third Part). Mobilization and English Manœuvres. The Trials of the Seaford.

AUGUST 11. The War in Corea. Launching of the Armored Cruiser Bruix. The Naval Manœuvres in the Channel and on the Ocean.

AUGUST 18. The End of the English Manœuvres.

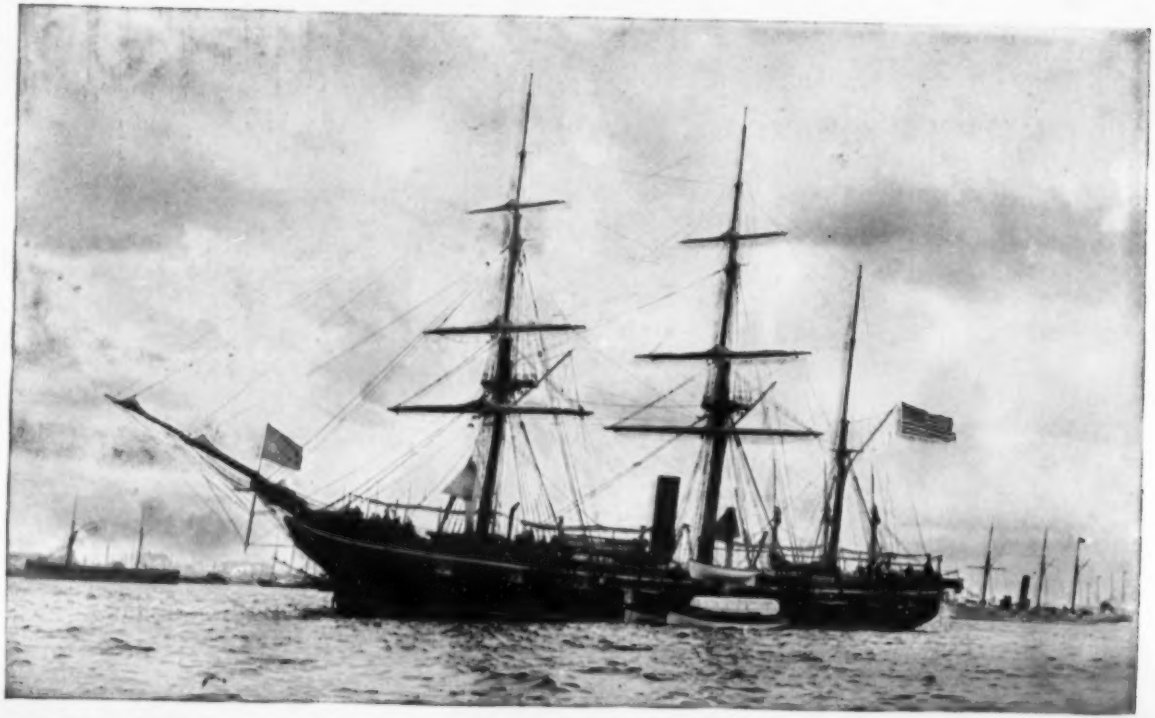
AUGUST 25. New Foreign Vessels of High Speed.

SEPTEMBER 1. A Visit to the Dock-Yards. The Trials of the Dispatch Torpedo-Boat d'Iberville.

SEPTEMBER 8. The War in Corea. The Supplying of R. F. Guns (continued). J. L.

REVIEWERS AND TRANSLATORS.

Lt.-Comdr. R. WAINWRIGHT, U.S.N. Lieutenant J. H. GLENNON, U.S.N.
Lieut. S. L. GRAHAM, " Lieutenant H. G. DRESEL, "
Lieut. ALBERT GLEAVES, " Professor JULES LEROUX.



FROM THE GRANITE MONTHLY.

THE KEARSARGE IN 1893.